ENLISTED CORRESPONDENCE COURSE

GUIDED MISSILEMAN 3 & 2

ASSIGNMENT BOOKLET

Prepared under the Supervision of

BUREAU OF NAVAL PERSONNEL

DEPARTMENT OF THE NAVY

NAVPERS 91360-A

CONTENTS

CAUTION

Your examination for advancement in rating will be based on the latest edition of the *Manual of Qualifications for Advancement in Rating* (NavPers 18068). It is possible that the qualifications for your rating may have changed since this correspondence course and its accompanying textbook were printed.

The study suggestions which are in this correspondence course, in the Navy Training Course, and in the current edition of *Training Publications for Advancement in Rating* (NavPers 10052) are intended to help you locate study materials on which the examinations will be based.

Be sure to refer to the latest edition of the *Manual of Qualifications for Advancement in Rating*, a copy of which is available from your division officer.

ASSIGNMENT BOOKLET

GUIDED MISSILEMAN 3 & 2

BOTH ANSWER SHEETS AND NCCC 86 FORM INCLUDED IN BOOKLET

SPECIAL NOTICE

Before commencing the course, consult with your Division Officer to determine whether your course is to be administered and graded by the Naval Correspondence Course Center or by the Command/Activity to which you are attached for duty.

If your course is to be administered and graded by the Naval Correspondence Course Center, follow the instructions outlined under the section which reads: *SPECIAL INSTRUCTIONS FOR STUDENTS WHOSE COURSES ARE ADMINISTERED AND GRADED BY THE CORRESPONDENCE COURSE CENTER.*

If your course is to be administered and graded by the Command/Activity to which you are attached for duty, in addition to any local instructions, follow the instructions outlined under the section which reads: *SPECIAL INSTRUCTIONS FOR STUDENTS WHOSE COURSES ARE TO BE ADMINISTERED AND GRADED BY THEIR LOCAL COMMAND.*

Inactive duty personnel will follow those instructions outlined for courses administered and graded by the Correspondence Course Center.

GENERAL INFORMATION FOR ALL NEW ENROLLEES ON HOW TO WORK THE COURSE

This correspondence course consists of a set of answer sheets, an assignment booklet, and a textbook. The textbook for this course is the Navy Training Course *Guided Missileman 3 & 2* (NavPers 10153).

Each assignment is made up of a series of questions or items based on assigned readings in the textbook. At the beginning of each assignment are listed the specific chapters which should be studied. First, however, look through the textbook and get acquainted with its general organization.

Check to see if there is an Errata Sheet included with this course. If there is, make all indicated changes and corrections in the assignment booklet and textbook before you start to study. Do not make any other marks in the textbook as it must be returned to the Naval Correspondence Course Center for reissue to other enrollees.

Now study thoroughly those pages of the text book listed for each assignment. Special attention should be given to the illustrations. They give a lot of information in a small amount of space. Making your own drawings and sketches will help you understand the explanations you read.

Work the quiz at the end of each chapter of the study text and check your answers with the correct ones at the back of the text.

When you have finished the required reading for an assignment, proceed to answer the questions in the assignment booklet. Read each question and its four choices carefully. Use your textbook to help you decide which is the best choice for the question and mark your answer directly in the assignment booklet. When you have finished one complete assignment in this manner, transfer your work to the answer sheet.

Use a separate answer sheet for each assignment and be sure that for each question you fill in only that space which is in the row numbered the same as your selection of the best of the four possible answers.

In order that the items may be scored accurately, you must follow the directions printed on the answer sheet. Be sure to supply all of the information requested.

Discussions of difficult points in the course with your Division Officer or shipmates can be helpful and are encouraged. However, the answers that you select must be your own.

ERASE completely any answers that you wish to change. Do not cross them out.

This course has been prepared by the U. S. Navy Correspondence Course Research Project, University of Chicago. It is administered by the U. S. Naval Correspondence Course Center.

SPECIAL INSTRUCTIONS FOR STUDENTS WHOSE COURSES ARE ADMINISTERED AND GRADED BY THE CORRESPONDENCE COURSE CENTER

You must attain an average grade of at least 3.2 to become eligible for a *Letter of Satisfactory Completion* for the course.

Adhere as closely as possible to the schedule prescribed by the Bureau of Naval Personnel of at least one assignment per month. If unusual circumstances prevent this, write to the Center explaining the difficulty. Time extensions are granted when justified. Remember, however, that unnecessary delay in completing the course, may, if you are a Reservist, prevent you from earning enough retirement credits to complete a year of Satisfactory Federal Service.

Before marking the answer sheet, fill in the blanks on the *BACK* of the answer sheet, giving your name and complete mailing address. Then fill in the blanks on the *FRONT* of the answer sheet with your name, rate and rating, assignment number, etc. Unless you supply all of this information, clearly, *IT WILL BE IMPOSSIBLE TO GIVE YOU CREDIT FOR YOUR WORK.*

Mail each answer sheet as soon as you have finished marking it. It will be returned to you after grading. Incorrect answers will be marked with the page number in the textbook where the correct answer material can be found.

When you have sent in answer sheets for all the assignments in the course and returned the text and any other instructional equipment, you will receive formal notification of your final grade for the course.

Self-addressed envelopes as required are provided for return mailing of your completed assignments and your text, etc.; be sure to put your name and address in the upper left-hand corner. When returning the textbook, be sure to complete and return "Material Credit Form NCCC-86." *Do not put any answer sheets in the same envelope with your text.* You may keep your assignment booklet, but the text must be returned to the Center.

It is important that you retain the last assignment of this course, after it has been graded and returned to you by the Correspondence Course Center. If you complete the course with a satisfactory average grade (3.2), your last assignment will be stamped with a certification of this fact. This certified last assignment is valid evidence of satisfactory completion.

SPECIAL INSTRUCTIONS FOR STUDENTS WHOSE COURSES ARE TO BE ADMINISTERED AND GRADED* BY THEIR LOCAL COMMAND

Adhere as closely as possible to at least a one-assignment-per-month schedule. If unusual circumstances prevent this, consult with your Division Officer explaining your difficulty and a time extension will be granted if justified. Unnecessary delay in completing the course may prevent you from becoming fully qualified to take the regularly scheduled fleet-wide competitive examination for advancement in rating.

Before marking the answer sheet, fill in the blanks on the *BACK* and *FRONT* of your answer sheet as directed by your local command directives. *Your address will be the division in which you are normally assigned for duty.*

GRADING: DO NOT SUBMIT ASSIGNMENTS TO THE CORRESPONDENCE COURSE CENTER FOR GRADING OR RECORDING

Submit your completed assignments to the officer designated to do your grading. He will grade your assignments and discuss with you any of the questions which you do not understand or score incorrectly. When the entire course has been completed and a satisfactory grade attained, a notation in your service record to that effect should be made by your local command and by this means you will be given credit for your work.

The Correspondence Course Center does not issue Letters of Satisfactory Completion to enrollees who have their courses administered and graded by their own command.

1

THE RATING, THE MISSILES, AND SOME BASIC PROBLEMS

Textbook assignment: chapters 1, 2, and 3

As a Guided Missileman assigned to an operating unit, you have a dual task. First, you must be familiar with the general principles and techniques that apply to all missiles; and secondly, you must be a specialist in the particular weapons that are employed by your outfit. Throughout your professional career, you will encounter a large field of varying equipment until, by the time you are a GS1 or Chief, you should be familiar with most of the major duties and problems of your specialty. It is only through interest in other fields and periodic transfer from specialty to specialty that you can accumulate the needed missile experience.

The purpose of chapter 1 of this assignment is to provide a general introduction to the duties that all Guided Missilemen have in common, and to give you an idea of the variety of billets that are open to the GS striker. It remains for each individual to keep posted on the latest qualifications that his rate and his technical specialty require.

1. Assume that you are an experienced GS3 who has just been transferred from a ship armed with guided missiles to a Naval Guided Missile School. Which of the following pieces of information can your new supervisor obtain by looking at your NEC code?

   1. The missile that you have been working on
   2. The number of practical factors for advancement to GS2 that you had completed at the time you were transferred
   3. The fact that you were trained at a class A school
   4. All of the above pieces of information

2. Which of the following personnel maintains the test equipment for antiaircraft missiles aboard an aircraft carrier?

   1. Electrician's Mates
   2. Radarmen
   3. Guided Missilemen
   4. Electronics Technicians

3. Which of the following men is most likely to be the first to handle a new guided missile?

   1. A GS assigned to a Navy depot
   2. A GS assigned to a ship armed with guided missiles
   3. A GS assigned to a Navy Test Center
   4. A GS assigned to a Naval Guided Missile School as an instructor

4. Assume that you are a GS3 working in the missile shop aboard a guided missile cruiser. You need some information on the past failures of the signal generation chassis used to test the beam-rider missile that your ship carries. You can find this information in the pertinent

   1. missile log
   2. equipment history card
   3. NavPers 760
   4. service test report

Assignment 1

● The highly specialized skills required of you as a Guided Missileman must be based on knowledge drawn from a variety of technical fields. Success in acquiring the knowledge, and thus the skills, does not depend simply upon your willingness to read large quantities of technical material. What is more important is the extent to which you are able to dig out the important ideas, to understand how these ideas fit into patterns, and to see how they apply to your work. It is of vital importance to the Navy and to your naval career that you develop this ability to really understand technical material. By improving your method of study, you can bring about a significant increase in your understanding, especially as the new method ripens into a study habit.

● The method of study recommended by the Navy is described in your textbook on pages 9 and 10. Items 5 through 7 refer to the following list of steps that you should use in studying a Navy Training Course:

A. Leafing through the book and reading passages that catch your eye
B. Reading the chapter introduction, headings, and subheadings
C. Reading each chapter in full detail
D. Reading the summary of the chapter
E. Reading the introductory material, the table of contents, and the index of the book
F. Checking the *Qualifications Manual* for the latest GS "Quals"

5. What is the purpose behind step F?

1. To make you aware of how the material in your textbook is organized
2. To make you aware of the manuals and technical publications that your textbook is based upon
3. To help you decide how much the Navy expects you to know about the material you are studying
4. To help you decide whether you need to take a preliminary course in mathematics

6. What is the purpose behind steps B and D?

1. To give you an idea of how each topic described in your textbook fits into the whole picture of the GS's job
2. To give you an idea of what other sources of information will help you master your qualifications for advancement
3. To help you decide whether or not you need to take a preliminary course in mathematics
4. To help you decide how intensively you will need to go into step C

7. In what order will you take the steps if you follow the recommended study method?

1. A, B, C, D, E, F
2. E, B, C, D, A, F
3. A, B, D, F, E, C
4. E, A, B, D, F, C

● Perhaps even more than the men in most ratings, Guided Missilemen are proud of the parts they play in today's Navy. They have a right to be, because they handle some of the most advanced weapons in the world.

Chapter 2 of this assignment presents some of the background on guided missiles. It will give you not only some of the historical tradition of your field, but also a sense of the tremendous progress that has been made in missile development.

8. The mathematical theory developed by Dr. R. H. Goddard was a major contribution to the field of

1. radar guidance
2. infrared homing
3. rocket propulsion
4. gyro stabilization

9. What was the first remote-controlled airborne vehicle to have a successful flight?

1. Pilotless aerial torpedo
2. Radio-controlled model airplane
3. Navy drone plane
4. German glide bomb

10. What type of guidance system was used by the Germans for most of their long-range missiles?

1. Radar-controlled
2. Radio-controlled
3. Preset mechanical
4. Infrared homing

11. The range of the V-2 was controlled by varying

1. the weight of the warhead
2. the size of the missile's fuel supply
3. the inclination of the missile during the propulsion stage
4. a self-contained timing device

12. The guided missile called the *Bat* was propelled by

    1. a pulse jet
    2. a turbojet
    3. gravity
    4. a rocket

13. Port and starboard control of the *Azon* missile was achieved by means of

    1. a preset rudder angle
    2. movements of the launching aircraft after missile release
    3. gyroscopic stabilization
    4. remote radio signals

14. What is the relationship between the frequency of infrared radiation and that of visible light?

    1. The frequency of infrared is higher.
    2. The frequency of light is higher.
    3. Both frequencies are the same.
    4. The frequency of infrared is zero.

15. An infrared device is able to "home in" on a military target primarily because

    1. all objects emit heat radiation
    2. the background of the target emits no radiations
    3. the target radiates more than its background
    4. the target radiates less than its background

● A number of the missiles you have studied in this assignment are famous "firsts" in guided missile history. For instance, the American *Bat* bomb was the first successful combat missile to carry a self-contained homing type guidance system. Let's see if you can identify some of these famous "firsts."

16. The missile that first made use of infrared homing was the

    1. *Felix*
    2. *Azon*
    3. *Gargoyle*
    4. *Roc*

17. Which missile was the first to be guided by an operator watching a television receiver?

    1. Attack drone
    2. *Gorgon*
    3. *Lark*
    4. *Roc*

18. The first American missile to use jet propulsion was the

    1. V-1
    2. *Lark*
    3. *Gorgon*
    4. *Sparrow*

19. The first antiaircraft missile to be installed on board ship as an operating weapon was the

    1. *Lark*
    2. *Sparrow*
    3. *Terrier*
    4. *Gargoyle*

20. What was the first operational missile bearing a mission designation of AAM?

    1. *Terrier*
    2. *Sparrow*
    3. *Gargoyle*
    4. *Regulus*

21. The *Sparrow* missile is guided by means of

    1. infrared homing
    2. a radar beam-riding system
    3. A self-contained, fully automatic radar
    4. television transmission

Assignment 1

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● Items 22 through 26 refer to the following information: Assume that your duty station is a missile depot. You are assigned to a unit that tests and maintains missiles of various types. On a particular morning, five missiles are delivered to the shop in their unopened packing crates. A striker asks you, as a rated man, to tell him what type of missile is contained in each crate. The missile designations stenciled on the respective crates are listed below. This is the only information available to you, but it should be sufficient to answer his questions.

A. RSAM-N-7a
B. RV-N-3
C. TSSM-N-5g
D. UAM-N-4e
E. XAAM-N-2c

22. What type of weapon is missile D?

1. Upper atmosphere research missile
2. Air-to-underwater missile
3. Ultraviolet homing missile
4. Underwater-to-air missile

23. Which of the missiles is a standard operational weapon?

1. Missile A
2. Missile C
3. Missile D
4. Missile E

24. Which of the missiles is in the developmental or experimental phase?

1. Missile A
2. Missile C
3. Missile D
4. Missile E

25. Which of the missiles is the seventh modification of the basic model?

1. Missile A
2. Missile C
3. Missile D
4. Missile E

26. What type of missile is missile B?

1. Rocket test vehicle
2. Radar training vehicle
3. Research vehicle
4. Radio telemetering vehicle

● Before you study missile guidance and control systems, you will find it helpful to learn something about the problems that missile designers had to consider before they could develop a workable missile. Some of these included the changing drag on a missile as the density of the air varies, the deflecting force of high winds in the troposphere, and the loss in effectiveness of control surfaces in the stratosphere and ionosphere. Chapter 3 of this assignment discusses problems like these.

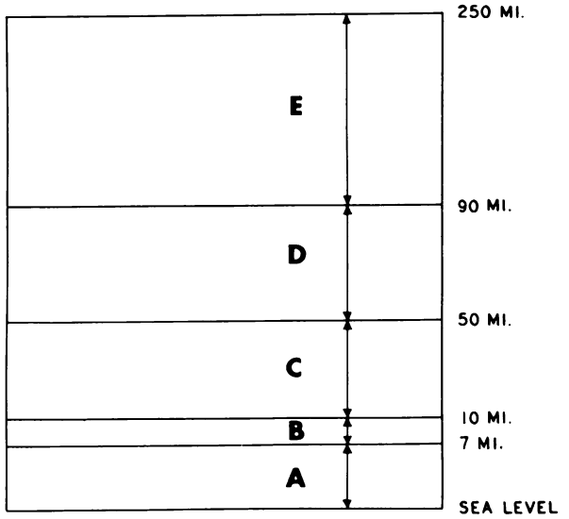


Figure 1A.—Diagram representing the atmosphere divided into regions.

27. If the air density at the bottom of region A in figure 1A is approximately 0.075 pounds per cubic foot, what is the density at the top of region A?

1. 0.010 lb. per cu. ft.
2. 0.018 lb. per cu. ft.
3. 0.025 lb. per cu. ft.
4. 0.038 lb. per cu. ft.

28. Because of the continuously decreasing air density, the drag on a rising missile decreases. The decrease in drag per unit change in altitude is greatest in the region of figure 1A labeled

1. A
2. B
3. C
4. D

29. The absolute pressure decreases in proportion to the decrease in air density. The absolute pressure is about half of the pressure at sea level when a rising missile reaches the

    1. top of region A in figure 1A
    2. middle of region A in figure 1A
    3. middle of region B in figure 1A
    4. top of region C in figure 1A

30. The temperature remains fairly constant in the region of figure 1A labeled

    1. A
    2. B
    3. C
    4. D

31. If the air temperature at sea level is 30° F., the air temperature in the middle of region A in figure 1A is about

    1. -12° F.
    2. -21° F.
    3. -33° F.
    4. -53° F.

32. During its rise a missile is exposed to the greatest atmospheric temperature variation rate in the region of figure 1A labeled

    1. A
    2. B
    3. C
    4. D

33. A rising missile encounters ionized air in

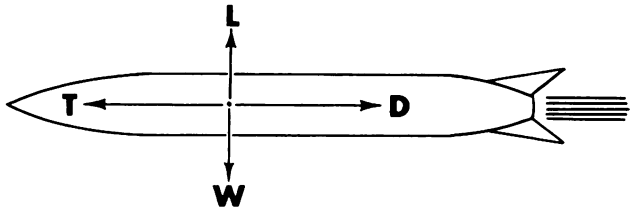
    1. region D in figure 1A only
    2. regions C and D in figure 1A
    3. regions D and E in figure 1A
    4. region E in figure 1A only

34. If a rising missile is traveling at a constant speed of 580 knots, in which of the following regions in figure 1A does it exceed Mach 1?

    1. Upper part of A
    2. B only
    3. B and part of C
    4. C only

35. The motion of a missile along the longitudinal axis is called

    1. roll
    2. pitch
    3. yaw
    4. translation



L = lift
W = weight
D = drag
T = thrust

Figure 1B.—Force vectors on a missile in flight.

36. If the missile shown in figure 1B is moving at a constant velocity and at a constant altitude, what must be the relationships between the force vectors?

    1. L = T and W = D
    2. L = W and D = T
    3. L = D and T = W
    4. L = D = T = W

37. What happens to the motion of the missile shown in figure 1B if D is less than T and W is less than L?

    1. It is accelerated both upward and in the line of flight.
    2. It is accelerated both downward and in the line of flight.
    3. It is accelerated upward and decelerated in the line of flight.
    4. It is decelerated in the line of flight and accelerated downward.

38. If the missile in figure 1B is accelerated at a rate of 160 feet per second per second because T is much greater than D, it undergoes an acceleration of

    1. 1 g
    2. 3 g's
    3. 5 g's
    4. 8 g's

● Items 22 through 26 refer to the following information: Assume that your duty station is a missile depot. You are assigned to a unit that tests and maintains missiles of various types. On a particular morning, five missiles are delivered to the shop in their unopened packing crates. A striker asks you, as a rated man, to tell him what type of missile is contained in each crate. The missile designations stenciled on the respective crates are listed below. This is the only information available to you, but it should be sufficient to answer his questions.

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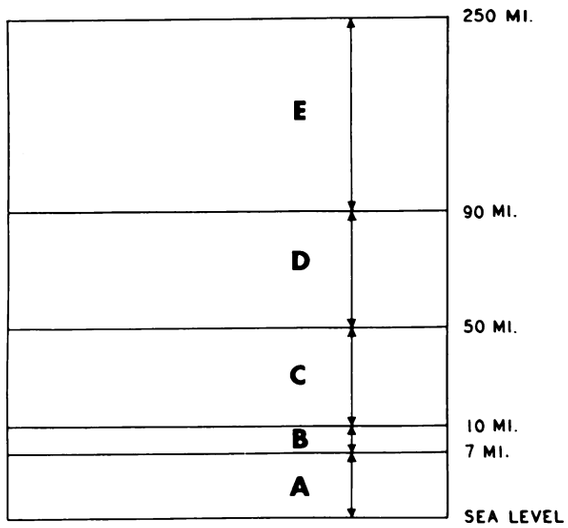

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2. middle of region A in figure 1A
3. middle of region B in figure 1A
4. top of region C in figure 1A

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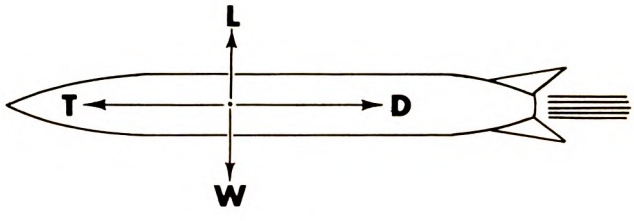
34. If a rising missile is traveling at a constant speed of 580 knots, in which of the following regions in figure 1A does it exceed Mach 1?

1. Upper part of A
2. B only
3. B and part of C
4. C only

35. The motion of a missile along the longitudinal axis is called

1. roll
2. pitch
3. yaw
4. translation



L = lift
W = weight
D = drag
T = thrust

Figure 1B.—Force vectors on a missile in flight.

36. If the missile shown in figure 1B is moving at a constant velocity and at a constant altitude, what must be the relationships between the force vectors?

1. L = T and W = D
2. L = W and D = T
3. L = D and T = W
4. L = D = T = W

37. What happens to the motion of the missile shown in figure 1B if D is less than T and W is less than L?

1. It is accelerated both upward and in the line of flight.
2. It is accelerated both downward and in the line of flight.
3. It is accelerated upward and decelerated in the line of flight.
4. It is decelerated in the line of flight and accelerated downward.

38. If the missile in figure 1B is accelerated at a rate of 160 feet per second per second because T is much greater than D, it undergoes an acceleration of

1. 1 g
2. 3 g's
3. 5 g's
4. 8 g's

● It will be evident to you that there is no ideal airfoil suitable for all speeds and altitudes. Each missile is equipped with airfoils suitable for the altitudes and airspeeds at which it will operate. When you have learned the principles of airfoil design and operation you will be able to look at a missile's control surfaces and estimate what it is designed to do.

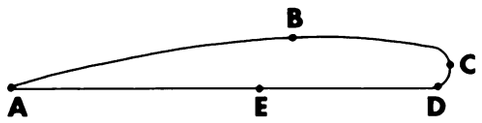


Figure 1C.—Cross section of a typical subsonic airfoil.

39. Most of the lift developed by the airfoil shown in figure 1C is due to the fact that dynamic pressure is less than static pressure around point

1. B
2. C
3. D
4. E

40. According to Bernoulli's principle, the velocity of the air flow around the airfoil shown in figure 1C is maximum in the region around point

1. A
2. B
3. C
4. D

41. When an airfoil of the type shown in figure 1C is in a stalled condition, the air ceases to flow smoothly between points

1. B and A
2. C and B
3. D and E
4. E and A

● During the period in which aircraft were starting to reach the transonic flight region it became necessary to compare the speed of the aircraft to the speed of sound. This was because of the changing characteristics of airfoils in the transonic region and the structural strains to which the aircraft were subjected. Airspeed indicators were calibrated in Mach numbers so that pilots would know when the aircraft was likely to be exposed to the dangerous forces created in the transonic region. Since missiles are also subject to such effects, this terminology has been adopted for missile work.

42. The expression °K. is used to indicate absolute temperature just as the expression °C. is used to indicate temperature on the centigrade scale. At which of the following temperatures is the speed of sound greatest?

1. 0° C.
2. 273° K.
3. 15° C.
4. 280° K.

43. If the speed of a missile is V, and the speed of sound is S, the Mach number M at which the missile is traveling is given by the formula

1. $M = V/S$
2. $M = SV$
3. $M = S/V$
4. $M = \sqrt{V}/S$

44. Assume that a missile is traveling at Mach 1 in a region where the speed of sound is 600 knots. What is the Mach number when the missile moves into a region where the speed of sound is 500 knots?

1. 0.9
2. 1.1
3. 1.2
4. 1.4

45. At an air temperature of 59° F., the region of transonic flight extends over the approximate range of airspeeds from

1. 500 knots to 800 knots
2. 550 knots to 850 knots
3. 600 knots to 900 knots
4. 650 knots to 950 knots

46. In which of the following flight regions are the effects due to the compressibility of air most pronounced?

1. Mach 0 to Mach 0.3
2. Mach 0.3 to Mach 0.75
3. Mach 0.75 to Mach 1.2
4. Above Mach 1.2

47. What happens to the density and pressure of the air in front of a blunt body that is accelerating?

1. Density increases and pressure decreases.
2. Both density and pressure increase.
3. Pressure increases and density decreases.
4. Both density and pressure decrease.

48. Which of the following conditions occurs as a missile passes through the transonic region?

1. The pressure wave travels faster and stays ahead of the missile.
2. The missile draws closer to its pressure wave and catches up with it at Mach 1.
3. A pressure wave travels with the missile at a constant distance in front.
4. The missile catches up with its pressure wave and finally leaves it behind.

49. Where is a shock wave likely to form first as the speed of a subsonic aircraft increases?

1. In front of the nose
2. On the fuselage
3. On the wing surface
4. In front of the wing surface

50. A shock wave is characterized by abrupt changes in air

1. density and pressure only
2. temperature and velocity only
3. pressure and temperature only
4. density, pressure, velocity, and temperature

51. In a region where the speed of sound is 720 knots, the effect of the compressibility of air on a missile is relatively unimportant until the speed of the missile reaches about

1. 180 knots
2. 220 knots
3. 460 knots
4. 590 knots

52. At which of the following speeds is the Mach cone sharpest?

1. Mach 0.7
2. Mach 0.9
3. Mach 1.0
4. Mach 1.2

53. Missiles and supersonic jets usually have sharp tapering noses in order to

1. prevent the formation of all shock waves
2. prevent the formation of normal shock waves
3. reduce the effects of normal shock waves
4. increase the angle of oblique shock waves

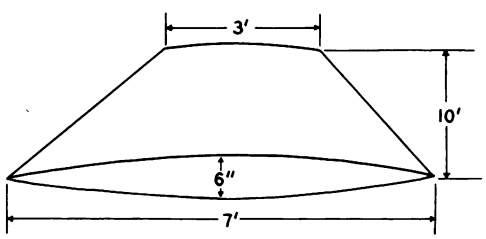


Figure 1D.—Supersonic wing.

54. The aspect ratio of the wing shown in figure 1D is approximately equal to

1. 0.5
2. 2.0
3. 4.0
4. 6.0

55. What type of airfoil is the wing shown in figure 1D?

1. Cambered
2. Double wedge
3. Modified double wedge
4. Biconvex

56. What is the thickness ratio of the supersonic wing shown in figure 1D?

1. 1/8
2. 1/10
3. 1/14
4. 1/20

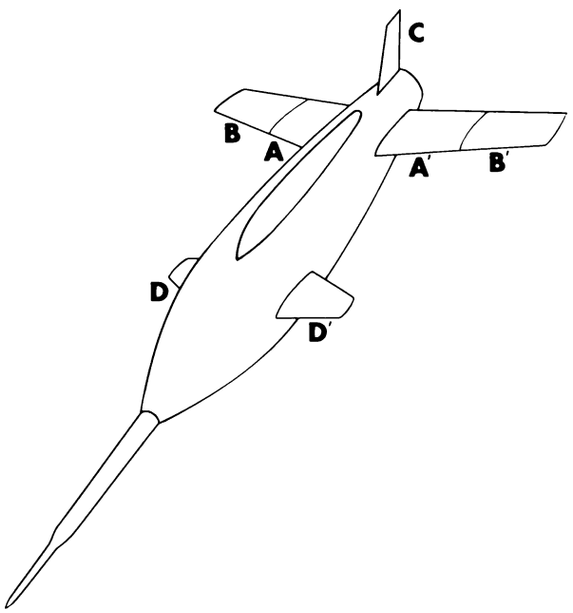


Figure 1E.—Missile in level flight attitude.

● Airfoils A and A′ are fixed; airfoils B and B′, C and C′, and D and D′ are movable. Airfoil C′ does not appear in the diagram, but does exist.

57. All of the airfoils on the missile shown in figure 1E are of the type called control surfaces except

1. A and A′ only
2. A and A′, and B and B′
3. C and C′, and D and D′
4. C′ only

58. What two airfoils on the missile shown in figure 1E must be turned in the same direction in order to control yaw?

1. A and A′
2. B and B′
3. C and C′
4. D and D′

59. The roll of the missile shown in figure 1E can be controlled by rotating which of the following airfoils in opposite directions?

1. B and B′ only
2. C and C′ only
3. D and D′ only
4. Either B and B′, or C and C′, or D and D′

60. The pitch of the missile shown in figure 1E can be controlled by rotating which of the following airfoils in the same direction?

1. B and B′ only
2. C and C′
3. D and D′ only
4. Either B and B′ or D and D′

61. Missiles with the type of control used in the missile shown in figure 1E are usually subject to which of the following limitations?

1. Loss of control at supersonic speeds
2. Poor durability of control surfaces
3. Loss of control at extreme altitudes
4. Poor maneuverability at low altitudes

62. The missile shown in figure 1E has two sets of airfoils for pitch control. Under which of the following flight conditions might both sets be required simultaneously to furnish sufficient control?

1. High speeds
2. Low speeds only
3. High altitudes only
4. Both low speeds and high altitudes

2

THE COMPONENTS; PROPULSION PLANTS; AUXILIARY POWER

Textbook assignment: chapters 4, 5, and 6

● Picture a disassembled guided missile with all its components lying in a jumbled heap. It looks like a pile of scrap metal and salvaged wire. Now contrast this picture with the sleek appearance of a fully assembled missile and you will begin to appreciate the importance of your job as a GS petty officer. You are the man who must transform this tangled maze of seemingly unrelated equipment into an operational weapon. In this assignment, you take the first step in mastering this job by going through a missile system section by section and learning the names and functions of the basic parts of the system.

You should pay special attention to the section on guidance control components that deals with gyroscopes. You may not understand exactly how gyroscopic precession works the first time you read about it, but understanding this subject thoroughly is worth all the time it takes because the operation of the entire guidance system is built around the reference in space established by the missile's gyroscopes.

Assignment 2

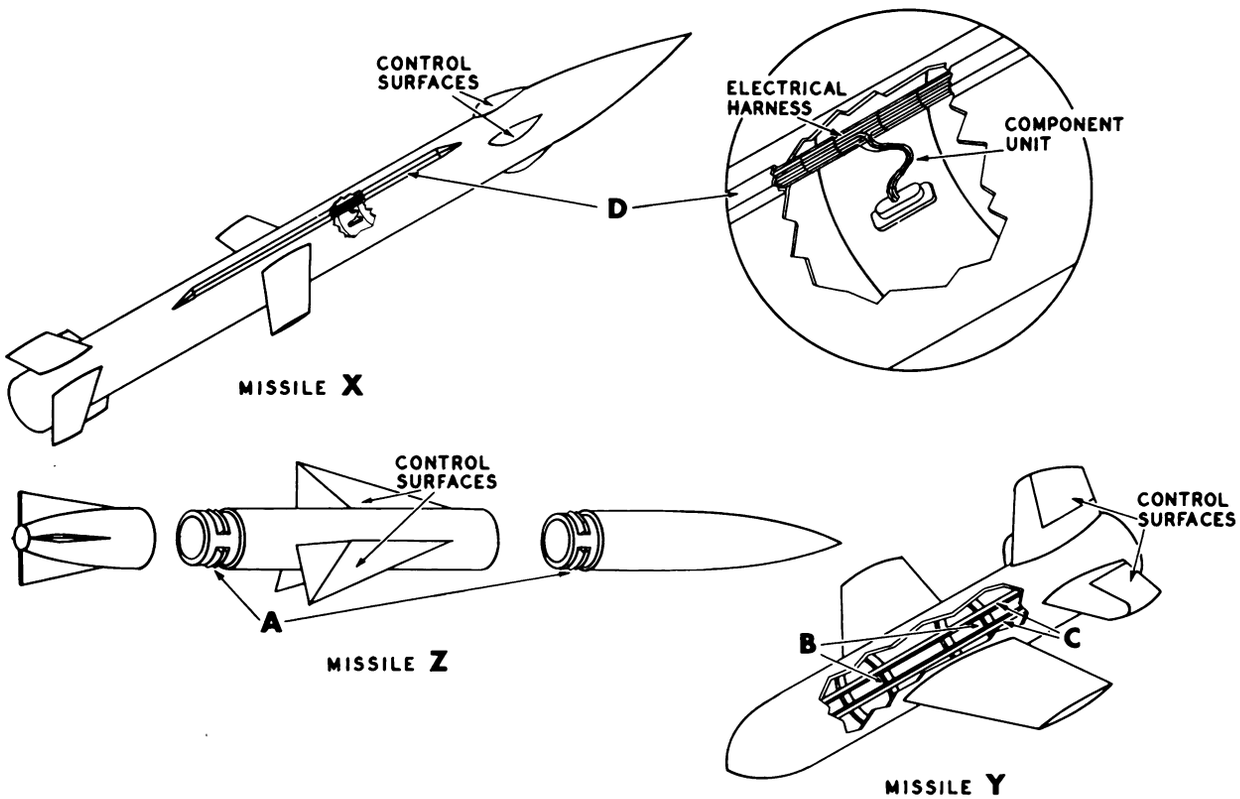


Figure 2A.

1. The fact that missile X and missile Z in figure 2A have noses that narrow to a point in ogive curves indicates that these missiles are designed to

   1. travel at subsonic speed
   2. carry proximity fuzes
   3. travel at supersonic speed
   4. carry fragmentation warheads

2. Which of the three missiles shown in figure 2A is likely to be slower than the other two?

   1. Missile X because its nose tapers in ogive curves
   2. Missile Y because it uses tail control
   3. Missile Z because it uses wing control
   4. Missile Y because of its blunt, round nose

3. The term "boattailed" is used to describe which of the missiles in figure 2A?

   1. Missile X only
   2. Missile Y only
   3. Missile Z only
   4. Missiles X and Y

4. The term "canard airframe" applies to which of the missiles in figure 2A?

   1. Missile X only
   2. Missile Y only
   3. Missile Z only
   4. Missiles X, Y, and Z

5. The fuselage of missile Y in figure 2A represents the type of construction known as

   1. cylindrical shell construction
   2. semimonocoque construction
   3. axial construction
   4. monocoque construction

6. What is the proper term for a reinforcing bulkhead like the one designated by the letter B in figure 2A?

   1. Firewall
   2. Strut
   3. Frame
   4. Stringer

7. In figure 2A, the reinforcing ribs designated by the letter C are known as

   1. struts
   2. stringers
   3. frames
   4. spars

8. The metal fairing designated by the letter D in figure 2A serves to house the electrical harness that connects missile components. This fairing assembly is known as

   1. an airfoil
   2. a channel
   3. a skid fin
   4. a tunnel

9. In figure 2A, an illustration of the breech-lock connection of missile sections is designated by the letter

   1. A
   2. B
   3. C
   4. D

10. What type airframe construction is normally used in surface-to-air missiles?

    1. Axial
    2. Monocoque
    3. Semimonocoque
    4. Cylindrical shell

Items 11 through 15 refer to the following list of destructive effects of missile warheads:

A. Violent burning
B. A high-pressure wave
C. Flying shrapnel
D. Blast, heat, and radiation
E. Blast plus explosive pellets
F. A jet of hot gases weighted with heavier material

11. Destructive effect B results from the detonation of

    1. explosive pellet warheads
    2. incendiary warheads
    3. shaped-charge warheads
    4. external blast warheads

12. Which of the following destructive effects is produced by a fragmentation warhead?

    1. B
    2. C
    3. D
    4. E

13. Destructive effect F is the major cause of damage resulting from the detonation of

    1. atomic warheads
    2. incendiary warheads
    3. shaped-charge warheads
    4. fragmentation warheads

14. Detonation of an explosive-pellet warhead results in destructive effect E, which is very effective against aircraft targets. What is the major obstacle to the operational use of this type of warhead at present?

    1. The lack of a satisfactory pellet fuze
    2. The lack of a satisfactory casing for such warheads
    3. The limited power of existing pellet charges
    4. The limited effective range of such warheads

15. Destructive effect D can be produced only by an atomic or thermonuclear explosion. Exposure to this radiation results in the death and sickness of personnel, an effect similar to the primary destructive purpose of

    1. incendiary warheads
    2. shaped-charge warheads
    3. fragmentation warheads
    4. biological warheads

Assignment 2

Items 16 through 20 refer to the following types of missile fuze types:

A. Acoustic
B. Delay
C. Electrostatic
D. Instantaneous
E. Ground-controlled
F. Photoelectric
G. Pressure
H. Radio

16. Which of the following groups of fuzes is composed entirely of proximity fuzes?

1. A, C, E, G
2. B, D, F, H
3. C, E, G, H
4. A, F, G, H

17. Which of the following pairs of fuzes are of the impact type?

1. A and G
2. B and D
3. E and G
4. D and E

18. Which of the following missile fuzes is most disturbed by vibrations from the missile that carries it?

1. A
2. C
3. F
4. G

19. Which of the following missile fuzes is restricted to use during daylight hours?

1. A
2. C
3. F
4. G

20. Which of the following proximity fuzes is most reliable for use in guided missiles?

1. A
2. C
3. E
4. H

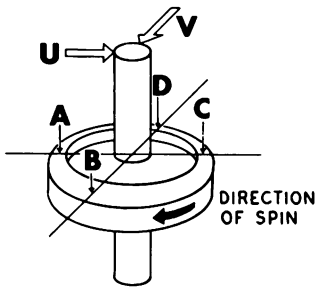


Figure 2B.

● When answering items 21 through 25, assume that the gyroscope in figure 2B is mounted as a free gyro, and that the rotor is spinning.

21. Assume that a torque is applied in the U direction to the gyro in figure 2B, causing the gyro to precess so that the rotor tilts. At what point in the figure will the rim of the rotor move downward as a result of the gyro's precession?

    1. A
    2. B
    3. C
    4. D

22. Assume that a torque is applied in the V direction to the gyro in figure 2B, causing the gyro to precess so that the rotor tilts. At what point in the figure will the rim of the rotor move downward as a result of the gyro's precession?

    1. A
    2. B
    3. C
    4. D

23. How many degrees of freedom are possessed by the free gyro shown in figure 2B?

    1. 1
    2. 2
    3. 3
    4. 4

24. Suppose that the gyro shown in figure 2B is mounted as a rate gyro. How many degrees of freedom will it possess?

    1. 1
    2. 2
    3. 3
    4. 4

25. Which of the following modifications of the gyroscope shown in figure 2B will increase its rigidity in space?

    1. Redesigning the gyro rotor so that more if its weight is found near the center
    2. Replacing the gyro rotor with a lighter one
    3. Increasing the rotation speed of the gyro rotor
    4. Decreasing the rotation speed of the gyro rotor

26. The primary function of a gyro pick-off is to

    1. increase the rigidity of the gyro
    2. restrict the number of degrees of freedom of the gyro
    3. produce an electrical signal proportional to gyro precession
    4. measure the speed of the gyro rotor

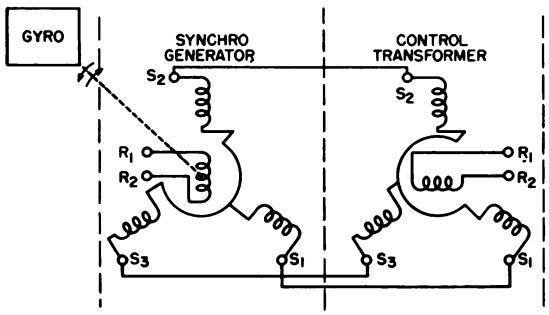


Figure 2C.

27. The amplitude of the signal that appears between points R1 and R2 of the control transformer in figure 2C is determined by the

    1. direction of gyro precession
    2. amount of displacement of the gyro gimbals due to precession
    3. rate at which the gyro precesses
    4. phase of the reference signal fed to the synchro generator

28. The phase of the signal that appears between points R1 and R2 of the control transformer in figure 2C is determined by the

    1. direction of gyro precession
    2. amount of displacement of the gyro gimbals due to precession
    3. rate at which the gyro precesses
    4. amplitude of the reference signal fed to the synchro generator

Assignment 2

29. A servo system is normally used to transform input electrical signals into corrections to the missile's flight path. The component of the servomechanism that acts directly upon the control surfaces to achieve these corrections is called the

    1. controller
    2. servo amplifier
    3. synchro
    4. control transformer

● Item 30 refers to the servo motor amplifier circuit described on pages 94 and 95 of your textbook. As you analyze this circuit, keep in mind the fact that the input error voltage will always be either in phase with the reference signal of 180° out of phase with it.

30. Assume that the servo motor is turning in a clockwise direction. What must you do to reverse the direction of rotation of the motor?

    1. Increase the amplitude of the error signal.
    2. Decrease the bias on the amplifier tubes.
    3. Increase the amplitude of the reference signal.
    4. Invert the polarity of the error signal.

31. What is the function of a radar beacon when it is used in a missile tracking system?

    1. To extend the tracking range
    2. To increase tracking accuracy at short range
    3. To provide range information to the missile
    4. To furnish reference points for the missile's homing system

32. The radio navigation tracking system compares signals from two radio transmitters to determine what flight corrections must be made. The two signals are compared for a difference in

    1. frequency
    2. time
    3. phase
    4. amplitude

33. The German V-1 missile was fitted with an air log which consisted of a small propeller connected to a counting device and which measured the distance the missile had traveled by counting the propeller revolutions. When the missile reached the proper range, the unit put out a signal that caused the missile to dive on its target. Components that perform functions of this type are called

    1. steering devices
    2. program devices
    3. directing devices
    4. tracking devices

● Information for items 34 and 35: Assume that Brown, GS2, is operating a missile equipped with a command guidance system. He observes the flight of the missile on a radar screen and operates the controls of a frequency-modulated radio receiver to guide the missile to its target.

34. The radar scope shows Brown the position of the missile and the target. What missile system function is performed by the radar?

    1. Tracking function
    2. Computing function
    3. Directing function
    4. Steering function

35. If the radio transmitter performs the directing function, what missile system function is performed by Brown?

    1. Tracking function
    2. Computing function
    3. Directing function
    4. Steering function

● Most of the work with missile propulsion plants and launchers is done by Gunner's Mates. But if you are attached to an operating unit, emergencies may come up and you will be called on to help in transporting a rocket motor or even in assembling one. Even in the regular course of your duties, you may be responsible for securing a missile to its launcher and "wringing out" the umbilical cable to ensure proper operation of the control circuits. The information in chapter 5 of your textbook gives you the background you will need to carry out such duties.

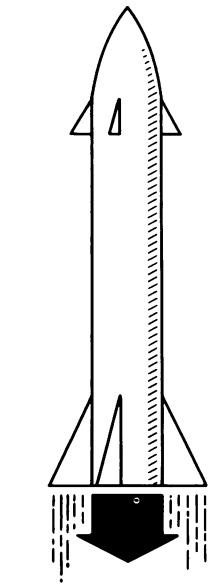


Figure 2D.

36. What is the correct term for the force that moves the missile shown in figure 2D?

    1. Horsepower
    2. Impulse
    3. Thrust
    4. Work

37. Assume that the force shown in figure 2D is the result of the combustion of fuel in a rocket motor. What is the impulse rating of the motor if it is designed to produce that force for 10 seconds when it is mounted on a test stand?

    1. 2,000 lb. sec.
    2. 20,000 ft. lb.
    3. 200,000 lb. sec.
    4. 2,000,000 ft. lb.

38. What is one advantage of a liquid-propellant rocket over a solid-propellant unit of comparable thrust rating?

    1. The liquid-propellant rocket carries its own oxidizer.
    2. The liquid-propellant rocket can operate for a longer period.
    3. The liquid-propellant rocket is simpler in construction.
    4. The liquid-propellant rocket can operate at higher altitudes.

39. The use of solid-propellant rocket motors has been restricted in the past to short-range missile applications. This limitation resulted from the need for large, heavy, combustion chamber casings. Recently, however, a reduction in casing size and weight has been made possible by the development of better cooling methods and

    1. fuels that are less susceptible to temperature extremes
    2. combustion chamber liners of a very lightweight metal
    3. fuels that are capable of efficient combustion at lower chamber pressures
    4. improved structural design of the combustion chamber

40. A liquid fuel that contains its own oxidizing agent is known as a

    1. catalyst
    2. monopropellant
    3. kinetic propellant
    4. bipropellant

Items 41 through 43 refer to the following list of typical rocket motor applications. In these items, your task will be to match the application with the proper type of rocket motor.

    A. A JATO unit to furnish additional thrust for take-off of a multiengine transport-type aircraft
    B. A sustaining rocket for a 2-ton missile
    C. A booster rocket for a 500-pound missile
    D. A sustaining rocket for an 8-ton missile
    E. An artillery rocket that can accelerate for a period of 15 seconds

41. For which of the following applications is an unrestricted burning solid-propellant rocket motor most suitable?

    1. A
    2. B
    3. C
    4. D

42. Which of the following rocket motors is most suitable for application E?

    1. Unrestricted burning solid-propellant rocket
    2. Restricted burning solid-propellant rocket
    3. Pressure-fed liquid-propellant rocket
    4. Pump-fed liquid-propellant rocket

Assignment 2

43. A pump-fed liquid-propellant rocket motor is required for which of the following applications?

1. A
2. B
3. C
4. D

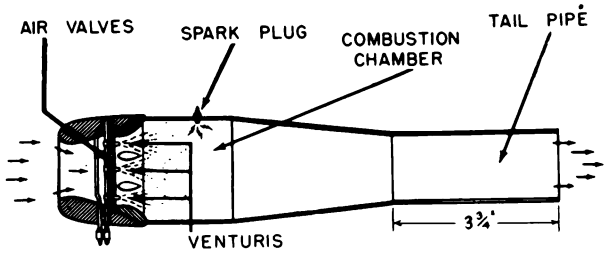


Figure 2E.—Pulse-jet engine.

● Information for items 44 and 45: The jet engine shown in figure 2E develops 600 pounds of thrust when it is securely mounted in a test rack on the ground.

44. How many pounds of thrust should the engine shown in figure 2E develop when it is moving at a speed of 400 mph?

1. 500 lb.
2. 640 lb.
3. 780 lb.
4. 840 lb.

45. The pulse-jet engine shown in figure 2E must have a conbustion chamber intake with a cross-section area of approximately

1. 400 sq. in.
2. 450 sq. in.
3. 500 sq. in.
4. 550 sq. in.

46. The main function of a missile booster is to

1. provide guidance during the acceleration period
2. propel the missile throughout its flight
3. provide power to accelerate the missile to operating speed
4. furnish mechanical motion to propel the missile from the launcher

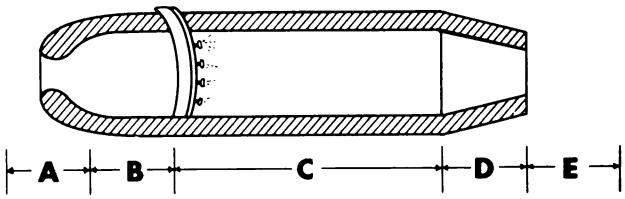


Figure 2F.—Ram-jet engine.

47. The ram jet is designed to build up a pressure barrier when it is in motion. As a result of this barrier, thrust is developed to propel the engine forward. When the engine in figure 2F is traveling at subsonic speeds, the pressure barrier will occur at some point in region

1. A
2. B
3. D
4. E

48. When the ram jet shown in figure 2F is in operation, the velocity of air or gases will be greatest in region

1. A
2. B
3. C
4. D

49. What is one advantage of the turbo jet that is not possessed by the ram jet?

1. Ability to operate at high altitudes
2. High rate of fuel consumption
3. Ability to develop static thrust
4. Increased efficiency at high speeds

50. What is the primary purpose of the gas turbine in a turbo-jet engine?

1. To drive the accessory units
2. To drive the compressor
3. To provide initial starting power
4. To decrease fuel consumption at high altitudes

Items 51 through 55 refer to the following list of missile launcher types:

A. Ramp
B. Vertical tower
C. Catapult
D. Trainable platform
E. Zero length
F. Vertical rail

51. What type of launcher has the least control over the initial motion of the missile?

1. B
2. C
3. D
4. E

52. The *WAC Corporal* is a high-altitude missile which is simple in design and construction. What type of launcher does it use?

1. B
2. D
3. E
4. F

53. What type of launcher is used to fire a *Regulus* missile from a guided missile cruiser?

1. A
2. B
3. E
4. F

54. What type of launcher uses mechanical motion to give initial acceleration to the missile?

1. A
2. B
3. C
4. D

55. A CVA type aircraft carrier may have several types of missile launchers, each of which is used with a specific type of missile. What type of launcher will be used on such a carrier to launch the *Regulus* missile?

1. B
2. C
3. D
4. E

Assignment 2

● A large part of your work as a GS will be concerned with missile auxiliary power systems and their components. If you are newly rated, some of your first jobs will probably include bleeding pressurized systems, cleaning commutators, and replacing brushes. As you gain more experience, you will be performing functional tests of the hydraulic, pneumatic, and electrical systems and making field modifications. The material presented in the remainder of this assignment will help to familiarize you with the types of components, systems, and circuits that you may encounter.

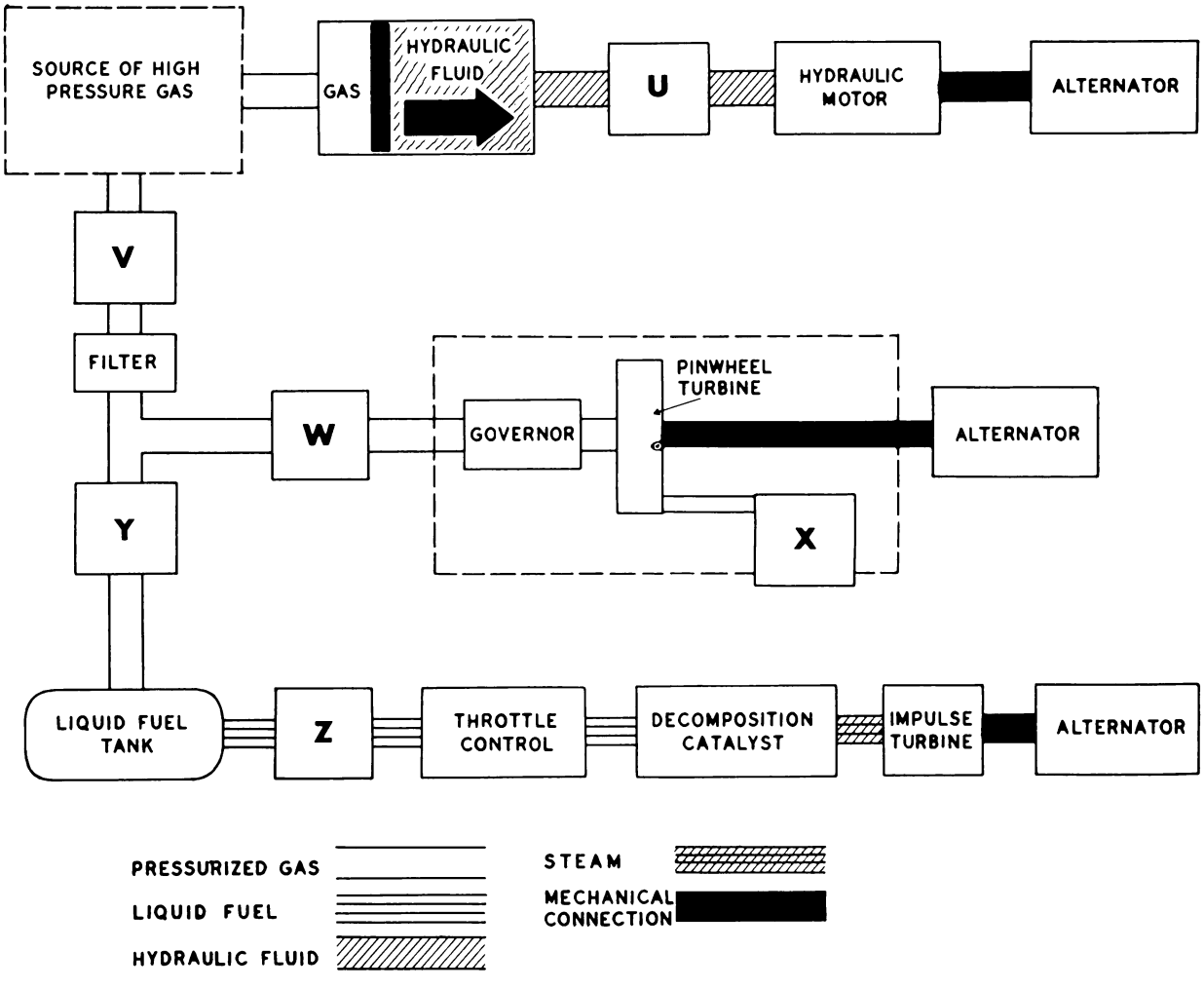


Figure 2G.—Composite system.

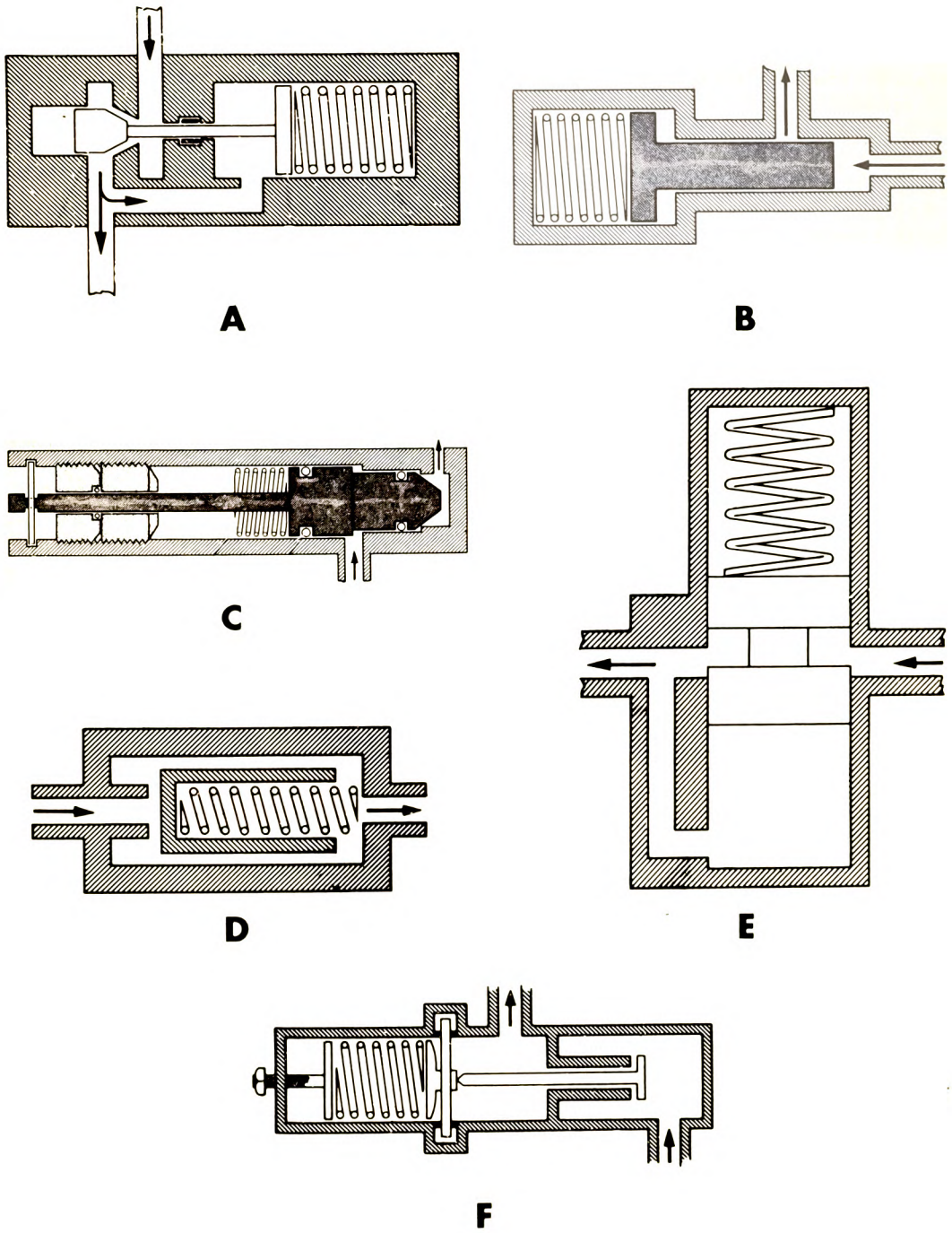


Figure 2H.—Types of valves.

Assignment 2

● Figure 2G is a diagram of a composite system set up to demonstrate three different systems for driving rotating electrical equipment. Items 56 through 61 are intended to teach you how the valves shown in figure 2H are used in such systems.

56. The valve at point V in figure 2G is designed to release the high-pressure gas to the rest of the system as soon as the release pin is removed. What valve in figure 2H most closely resembles the valve used at point V?

1. Valve A
2. Valve B
3. Valve C
4. Valve D

57. The purpose of the valve at point W in figure 2G is to lower the high input pressure to the optimum operating pressure for the pinwheel type turbine. A constant output pressure is maintained by the action of a diaphragm that controls gas flow. What valve in figure 2H most closely resembles the valve used at point W?

1. Valve A
2. Valve C
3. Valve D
4. **Valve F**

58. The valve at point X in figure 2G is used to vent the gas to the atmosphere after it has been used to power the pinwheel turbine. This valve is opened by very slight pressure and functions mainly to keep outside air from entering the system when the turbine is not being operated. What valve in figure 2H most closely resembles the valve used at point X?

1. Valve A
2. Valve B
3. Valve D
4. Valve E

59. The valve at point Z in figure 2G serves to ensure that the fuel flow will be unidirectional. What valve in figure 2H most closely resembles the valve used at point Z?

1. Valve B
2. Valve C
3. Valve D
4. Valve E

60. The valve at point U in figure 2G makes use of a spring-loaded piston to regulate the flow of hydraulic fluid so that the pressure at the outlet of the valve remains constant. What valve in figure 2H most closely resembles the valve used at point U?

1. Valve B
2. Valve C
3. Valve E
4. Valve F

61. The valve at point Y in figure 2G serves to lower the high input pressure to the value needed to pressurize the fuel system. Regulation of the output pressure is accomplished by a spring-loaded differential piston linked to a poppet valve that controls gas flow. What valve in figure 2H most closely resembles the valve used at point Y?

1. Valve A
2. Valve C
3. Valve E
4. Valve F

● Items 56 through 61 cover only one aspect of auxiliary power supplies—the valves they use. Some of the other aspects of these power supplies are covered by items 62 through 65.

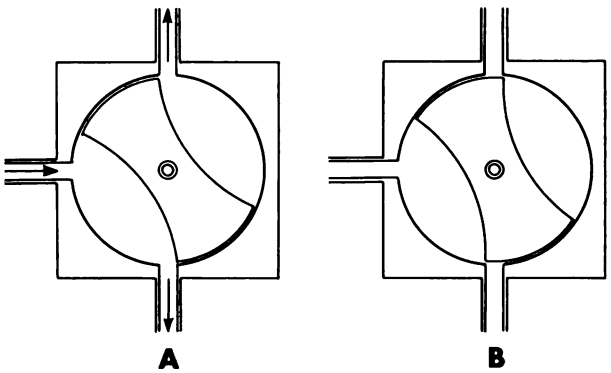


Figure 2J.

62. Figure 2J shows the governor of a pinwheel turbine with the shutter in two positions. During normal operation of the turbine, the shutter will move from position A to position B as a result of

1. an increase in the pressure exerted by the torsion bar spring
2. a decrease in inlet pressure
3. an increase in the speed of the pinwheel
4. a decrease in the speed of the pinwheel

63. The hydraulic motor shown in figure 2G is of the rotating barrel type. It has 7 pistons fed by 6 cylinder ports. The extra piston functions to

1. relieve excess pressure
2. return hydraulic fluid to the reservoir
3. ensure smooth, uninterrupted operation
4. increase the maximum torque of the motor

64. What type of fuel is normally used to power an impulse turbine such as the one shown in figure 2G?

1. A monopropellant, because it can be handled with relative safety
2. A bipropellant, because it delivers more power than other types
3. A monopropellant, because its use results in relatively low turbine inlet temperatures
4. A bipropellant, because it will require less storage space than other types

65. What kind of turbine is used in a liquid propellant system like the one shown in figure 2G?

1. Steam-driven single-entry
2. Steam-driven multiple re-entry
3. Gas-driven single-entry
4. Gas-driven multiple re-entry

66. What is the purpose of the vents in the cells of a nickel-cadmium battery?

1. To permit the escape of gases during battery charge
2. To permit the escape of gases during battery discharge
3. To allow outside air to enter the cells for cooling purposes
4. To allow outside air to enter the cell during battery discharge and to equalize internal and external pressure

67. Which of the following processes occurs in a nickel-cadmium cell during discharge?

1. The specific gravity of the electrolyte drops.
2. The positive plate gradually changes from nickel oxide to metallic nickel.
3. Oxygen bubbles accumulate around the negative plate.
4. The negative plate gradually changes from metallic cadmium to cadmium oxide.

68. The electrolyte used in a lead-acid battery is sulfuric acid. What electrolyte is used in a nickel-cadmium battery?

1. Sulfuric acid
2. Potassium carbonate
3. Potassium hydroxide
4. Hydrochloric acid

69. What method does a GS use in charging nickel-cadmium batteries?

1. Constant current method
2. Float method
3. Constant voltage method
4. Stepped constant current method

● Information for items 70 and 71: Assume that a-c generator N is a 12-pole flux switching alternator that is designed to operate at a certain standard number of revolutions per minute and that it has an output frequency of 800 cps when it operates at that speed. Generator M is a conventional alternator that is designed to operate at the same standard speed and that has the same output frequency when it operates at that speed.

70. Both alternators must have a standard operating speed of

1. 3,000 rpm
2. 3,400 rpm
3. 4,000 rpm
4. 4,400 rpm

71. How many poles does alternator M have?

1. 8 poles
2. 12 poles
3. 16 poles
4. 24 poles

72. The dynamotor succeeds in making highly efficient use of its magnetic field by

1. using an inductor-type rotor
2. rotating the field rather than the armature
3. using the same field for both motor and generator
4. winding the field coil on a hard steel core

Assignment 2

73. The generator winding of a dynamotor is composed of more turns than the motor winding in order to

1. produce a high current output
2. increase the voltage across the field coil
3. produce an output voltage higher than that of the input
4. increase the starting torque of the armature

74. What purpose is served by the capacitor located across the input to the d-c motor of a dynamotor?

1. To keep arcing between the brushes and the commutator at a minimum only
2. To eliminate interference from high-frequency currents caused by sparking brushes only
3. To keep commutator ripple at a minimum only
4. All of the above purposes

75. Which of the following electromechanical devices changes direct current into alternating current?

1. A motor
2. An inverter
3. An alternator
4. A dynamotor

76. The d-c motor of an inverter picks up speed and begins to go faster than the speed control governor is set for. What action does the regulator take to slow the motor down?

1. The regulator increases the resistance of the shunt field.
2. The regulator decreases the resistance of the shunt field.
3. The regulator triggers a relay that connects the series speed control winding.
4. The regulator triggers a relay that disconnects the series speed control winding.

77. The devices that short out the series wound field of the inverter to make it operate like a shunt wound motor include two running relays. What is the source of the voltage that energizes the second running relay?

1. The positive brush of the d-c armature
2. The negative brush of the d-c armature
3. The positive terminal of the series field
4. The negative terminal of the d-c input

3

MISSILE GUIDANCE SYSTEMS

Textbook assignment: chapters 7, 8, 9, and 10

● This assignment is designed to give you one single valuable asset—the ability to think in terms of a total missile system. The chapters cover different kinds of guidance systems, but your approach to each one should be the same. You must try to develop a good mental picture of all of the system's components and understand how each one affects the operation of all the others.

It won't be enough to just learn the sequence of the blocks in each block diagram; you must also learn why the blocks come in that sequence. In doing this, you learn not only where the input signals to each block come from and where the output signals go, but you learn what the signals look like and why it is necessary for the system to develop each one.

When your mental picture of a missile system is as complete as this, you will be able to explain the system to others intelligently, and you will be able to solve operational and maintenance problems effectively. For instance, you won't be stopped by an operational maintenance check that doesn't check out; you will be able to track down the cause of the malfunction.

● Items 1 through 3 refer to the following elements of surface-launched missile control:

Source of signals

A. Heat radiation that comes from the target
B. Radar radiations that come from the missile and are reflected by the target
C. Radar radiations that come from the launching site and are reflected by the target
D. Radar radiations that come from the launching site and are reflected by both the missile and the target
E. Radio control signals that come from the launching site

Location of computer

F. In the missile
G. At the launching site

1. What elements of missile control are used in the command guidance system?

   1. B and F
   2. D and F
   3. B, E, and G
   4. D, E, and G

2. What elements of missile control are used in the beam-rider guidance system?

   1. B and G
   2. C and G
   3. D and F
   4. B and F

3. What element of control is included in a semiactive homing system?

   1. A
   2. B
   3. C
   4. D and E

● One of the problems that you will meet in the study of radar is that of dealing with extremely short intervals of time. In the life of most persons, a second is a very short time period, but to the radarman a second can represent an enormous period of time. This is a consequence of the great speed of transmission of electromagnetic radiation. So you must become accustomed to thinking in terms of microseconds.

The best way to visualize the sequence of events that take place in any radar set is to draw graphs of the various electrical signals on a time scale.

Items 4 through 6 will reveal some of the information that such graphs contain.

Assignment 3

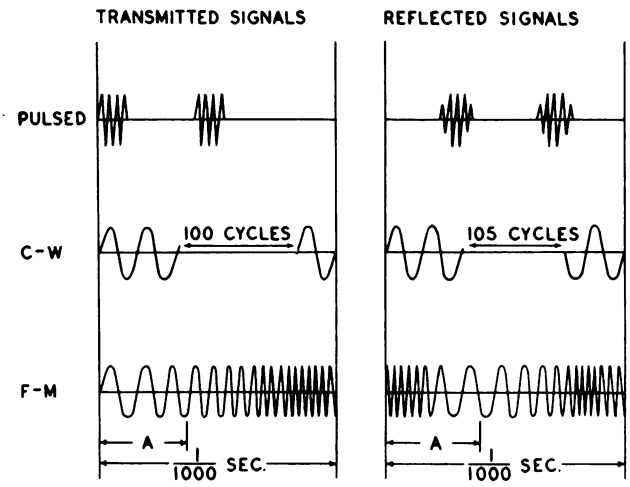


Figure 3A.

● The waveforms shown in figure 3A are graphs of the voltage variations during a chosen time interval for equipment like the missile radars discussed in the textbook. The signals are not intended to duplicate those produced by real equipment, but only to demonstrate the principles used in such equipment.

Note that the signal frequencies may be found by

$$\text{frequency} = \frac{\text{number of cycles}}{\text{seconds}}$$

4. What is the pulse repetition frequency of the radar signal shown in figure 3A?

   1. 500 pulses per sec.
   2. 1,000 pulses per sec.
   3. 1,500 pulses per sec.
   4. 2,000 pulses per sec.

5. The frequency of the reflected CW signal shown in figure 3A differs from the frequency of the transmitted signal. This indicates that the range of the target is changing. What is the size of this frequency difference?

   1. 1,000 cps
   2. 2,500 cps
   3. 5,000 cps
   4. 15,000 cps

6. The frequency of the reflected FM signal shown in figure 3A is much higher than the transmitted signal during any such interval as A. What does the frequency difference indicate?

   1. The relative speed of the target is great.
   2. The range of the target is great.
   3. The relative speed of the target is small.
   4. The range of the target is small.

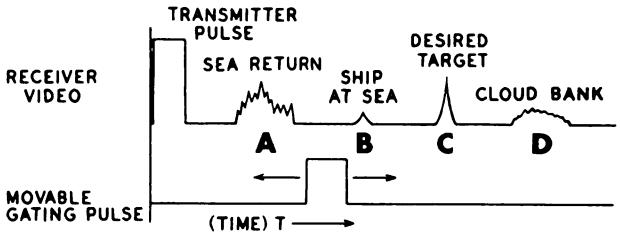


Figure 3B.

● The receiver video signals shown in figure 3B are typical of the signals that a missile-borne radar is likely to pick up. These signals appear at the output of the receiver during the search phase of operation. After the receiver locks on, the output is quite different because of the action of the gate pulse and the enabling voltage. Items 7 and 8 discuss the action of the radar during the range-tracking phase.

7. If the radar whose signals are shown in figure 3B is locked on the desired target and the range of the target is decreasing, how does the gate pulse react to the changing range?

   1. It moves to the right indicating greater time delay.
   2. It remains in the same position throughout range tracking.
   3. It moves to the left indicating less time delay.
   4. It unlocks from the target and moves out to greater range.

8. After the radar whose signals are shown in figure 3B is locked on the desired target echo, the receiver enabling pulse will eliminate all signals except the

   1. transmitter pulse
   2. desired target echo
   3. transmitter pulse and enabling pulse
   4. enabling pulse

9. If it were possible to build a source of electromagnetic radiation that was a true point source, and to place it at the exact focal point of a parabolic reflector, how would the width of the radiated beam vary as the range increased?

   1. The beam would be cone shaped and would increase in width.
   2. The beam would be constant in width, and this width would be equal to the width of the parabola.
   3. The beam would be cone shaped and would decrease in width.
   4. The beam would be cigar shaped and would increase in width.

10. The transmitted beam of an actual radar is never made up entirely of parallel rays because

    1. a perfect parabola is too hard to construct
    2. the antennas are not point sources
    3. minor lobes are always present
    4. electromagnetic energy does not travel in straight lines

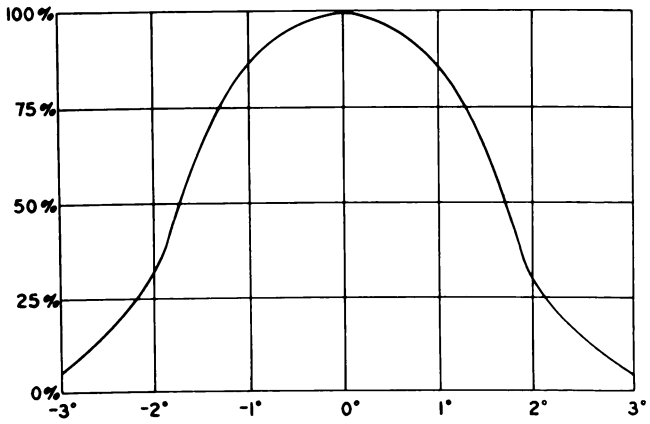


Figure 3C.—Relative energy in the reflected radar signal at various angles off the center of the beam.

11. The directivity of an antenna is frequently specified by the angles at which the reflected power is one-half of the maximum at 0°. These angles are called half-power points. What are the approximate half-power points of the antenna whose directivity is plotted in figure 3C?

    1. ± 1°
    2. ± 1 3/4°
    3. ± 2 1/4°
    4. ± 3°

12. Assume that a radar that has the directivity indicated in figure 3C is beamed at two targets with the same range. What is the smallest angle of separation between the targets that will permit the radar to see them as two separate targets?

    1. About 1/2° to 1°
    2. About 1° to 2°
    3. About 3° to 4°
    4. About 5° to 6°

13. Assume that the same parabolic reflector is used to transmit each of the following frequencies. At which of these frequencies will the radar beam be the narrowest?

    1. 1,500 mc. (L band)
    2. 3,000 mc. (S band)
    3. 9,000 mc. (X band)
    4. 21,000 mc. (K band)

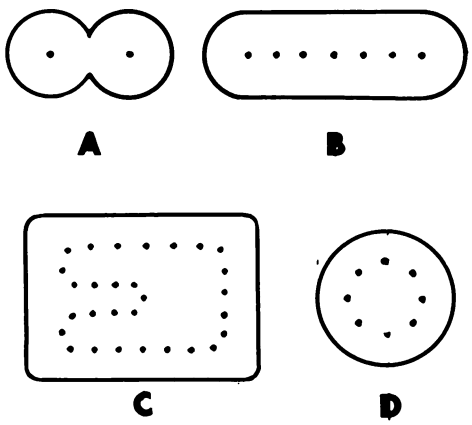


Figure 3D.—Radar scanning patterns. These diagrams illustrate the patterns described in space by the main antenna lobe in various types of scanning. The dots indicate successive positions of the center of the lobe. The solid lines indicate the outer edges of the beam.

14. In figure 3D, a beam in conical scan and a beam in lobe switching operation are represented by patterns

    1. A and C
    2. A and D
    3. B and C
    4. C and D

15. If the target happens to be dead ahead, how will the relative amplitude of the echo signals vary as the antenna dish rotates in conical scan?

    1. The amplitude will fluctuate between 0 and 100 percent of maximum.
    2. The amplitude will remain at about 80 percent of maximum.
    3. The amplitude will fluctuate between 0 and 20 percent of maximum.
    4. The amplitude will fluctuate between 30 and 100 percent of maximum.

16. If the pulse rate frequency of a conical scan antenna is 2,000 pulses per second and the antenna spins at the rate of 3,000 rpm, how many echo pulses appear during one revolution of the dish?

    1. 12
    2. 29
    3. 40
    4. 101

● Items 17 through 20 are based on the discussion of a typical missile radar system found in pages 179 through 183 of your textbook.

17. The magnetron receives the high voltages it requires for its operation from the

    1. synchronizer
    2. modulator
    3. duplexer
    4. klystron

18. How do the radar signals get from the antenna to the duplexer?

    1. Over coaxial cable
    2. Over uninsulated high-frequency cable
    3. Through waveguide sections that also serve as the gimbals
    4. Through waveguide sections located adjacent to the gimbals

19. Assume that a certain missile radar system is designed to have i-f voltages of exactly 60 megacycles. At the instant that the magnetron puts out a signal of 9,320 megacycles, the automatic-frequency-control system causes the klystron local oscillator to put out a signal with a frequency of

    1. 9,340 mc.
    2. 9,380 mc.
    3. 9,400 mc.
    4. 9,420 mc.

20. The receiver enabling pulses, which were discussed earlier in this assignment, actually control the i-f amplifiers by gating the i-f circuits. These pulses originate in the

    1. AFC circuits
    2. range tracking unit
    3. error signal circuits
    4. mixer section

● Item 20 brings you to the end of chapter 7. You have learned the basic processes of missile guidance as they apply to surface launched missiles and you have learned something about the use of radar in missiles with active homing guidance. In the next part of this assignment, you will study beam-rider guidance systems.

21. During both the automatic-pilot and the beam-guidance functions, the wing-actuating mechanisms are controlled by a system known as the

    1. deflection system
    2. gyroscopic system
    3. servo system
    4. accelerometer system

22. In what unit are error signals added together before being fed to the servo system?

    1. Summing amplifier unit
    2. Accelerometer unit
    3. Rate gyro unit
    4. Coincidence amplifier unit

23. How does the free gyro provide a reference for the missile?

1. By changing its position in response to missile pitch
2. By maintaining a fixed position in space
3. By changing its position in response to missile yaw
4. By carrying out a preset sequence of position changes

24. What is the purpose of the feedback voltages that are fed to the summing amplifier?

1. To prevent the missile from swinging back and forth through the desired heading
2. To increase the voltage of the wing deflection commands from the free gyro
3. To prevent excessive deflection of the missile control surfaces
4. To increase the rate at which deflection signals are applied to the wings

25. Unusually large error signals can result in wing deflections which place too much strain on the missile's airframe. Such extreme wing deflections are prevented by the action of the

1. feedback voltages from accelerometers
2. roll control bias voltage
3. limiters in the summing amplifier
4. mechanical stops on the wings

26. One of the advantages resulting from the use of roll control is that

1. a free gyro unit is no longer required
2. the necessity for feedback voltages is eliminated
3. the corrections that must be made by the autopilot are increased
4. the corrections that must be made by the autopilot are decreased

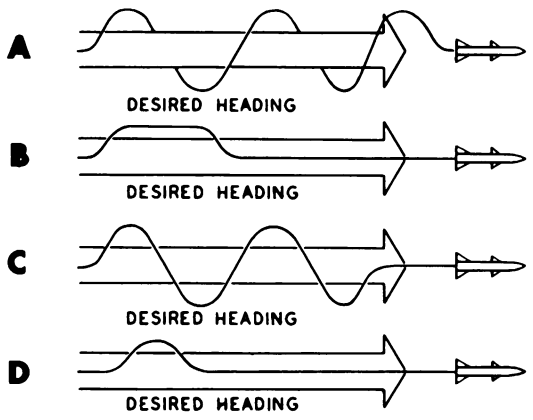


Figure 3E.

27. Assume that during the autopilot phase, a beam-rider missile is thrown off course by a sudden gust of wind. If the missile is provided with roll control, which of the diagrams in figure 3E best describes the missile's flight path as it corrects for the error?

1. A
2. B
3. C
4. D

28. Feedback voltages for roll control are provided by the output of the

1. accelerometer unit
2. roll rate gyro unit
3. free gyro unit
4. servo amplifier unit

29. What are the two primary functions of the fire-control radar?

1. Target detection and ranging
2. Target tracking and fighter control
3. Target acquisition and missile tracking
4. Target tracking and missile guidance

30. The pulses that are used to keep the scan axis of the fire-control radar pointed at the target are known as

    1. dual guidance pulses
    2. tracking pulses
    3. acquisition pulses
    4. scan pulses

● Figure 3F shown four missiles flying in different portions of the guidance beam. It also shows the set of dual pulse signals that each missile receives during a single revolution of the beam center.

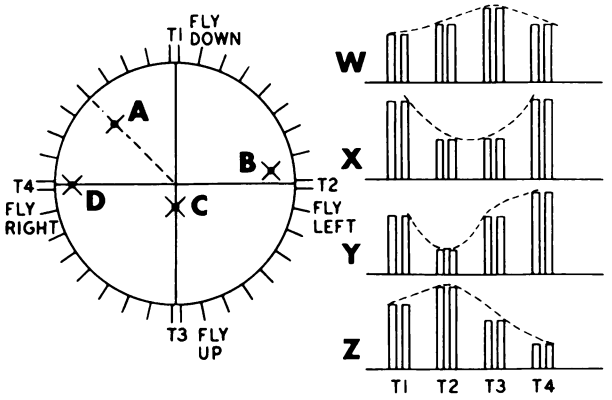


Figure 3F.

31. Which set of dual pulse signals shown in figure 3F is received by missile C?

    1. W
    2. X
    3. Y
    4. Z

32. Which set of dual pulse signals shown in figure 3F is received by missile D?

    1. W
    2. X
    3. Y
    4. Z

33. Which of the missiles shown in figure 3F will NOT roll as it returns to the center of the scan axis? (Remember that up-down error signals are converted into pitch signals and left-right error signals are converted into yaw error signals.)

    1. Missile A
    2. Missile B
    3. Missile C
    4. Missile D

34. What is the function of roll axis control during the guidance phase?

    1. To decrease the corrections that must be made by the guidance system
    2. To ensure that the missile always follows a spiral flight path
    3. To bring into equal play the lifting power of all of the wing surfaces
    4. To maintain the proper reference with the free gyro in the fire-control system

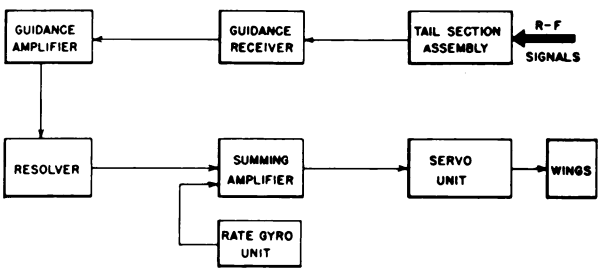


Figure 3G.—Beam-rider guidance system.

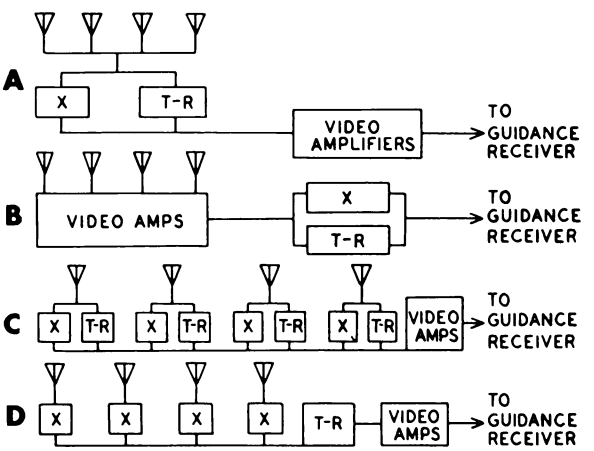


Figure 3H.

35. In which of the components shown in figure 3G is the roll command voltage developed?

    1. Resolver
    2. Rate gyro unit
    3. Summing amplifier
    4. Servo unit

36. Which of the simplified block diagrams shown in figure 3H most accurately represents the kind of tail assembly that would be found in a beam-rider system like the one shown in figure 3G? (In each one, the letter X stands for a crystal detector.)

1. A
2. B
3. C
4. D

37. Which component of the system shown in figure 3G produces four error voltages, each with a d-c value determined by a corresponding guidance pulse?

1. Tail section assembly
2. Guidance receiver
3. Guidance amplifier
4. Component resolver

38. What is the purpose of the delay lines in the guidance receiver shown in figure 3G?

1. To delay the guidance signals so that all four coincidence tubes conduct simultaneously
2. To delay the initial pulse of each dual pulse so the coincidence tubes can sort the guidance signals into the proper channels
3. To delay the tracking pulses to allow the guidance pulses to pass through the coincidence tubes
4. To delay the guidance pulses to allow the tracking pulses to pass through the coincidence tubes

39. What characteristic of the error signal produced by the guidance amplifier in figure 3G indicates the direction of the missile's error?

1. D-c value
2. Phase
3. A-c amplitude
4. Frequency

40. What characteristic of the error signal produced by the guidance amplifier in figure 3G indicates the size of the missile's error?

1. D-c value
2. Phase
3. A-c amplitude
4. Frequency

41. How does the component resolver in figure 3G act upon the input up-down and left-right error signals to change them into pitch and yaw error signals?

1. Rate gyro signals are combined in two sets of dual windings with the input signals so that the response of the missile is damped.
2. The a-c input signals are demodulated so that the pitch and yaw error signals are d-c voltages.
3. The input signals are coupled from a set of stationary windings to a set which moves with the airframe so that the value of the pitch and yaw errors is related to wing position.
4. Signals from the windings on two gimbal rings of a free gyroscope are added algebraically to the input signals so that the output error voltages are functions of the missile's roll attitude.

42. During the guidance phase, the roll control signal is derived from

1. a fixed roll bias voltage
2. a comparison of the tracking pulse amplitudes
3. the output of the free gyro
4. a comparison of the pitch and yaw error signals

43. What is the purpose of the rate gyro unit?

1. To provide automatic roll control
2. To increase the rate at which the missile responds to error signals
3. To provide the total error signal by adding the pitch and yaw error voltages
4. To decrease the rate at which the missile responds to error signals

● Item 43 brings you to the end of the chapter on beam-rider guidance systems. In the next part of this assignment, you return to homing guidance systems. You are already familiar with radar homing. Now you will learn something about infrared homing.

44. A homing missile can be designed to follow either a pursuit course or a lead course. What is the major disadvantage of a pursuit course in intercepting high-speed targets?

1. The speed of the target may exceed that of the missile.
2. The danger of loss of lock-on due to overcorrection is too great.
3. The rate of turn required near the target may exceed the missile's capabilities.
4. The required deviation from a line-of-sight bearing calls for heavy, complicated equipment.

Assignment 3

45. How does the use of lead homing for homing missiles solve the problem of intercepting high-speed targets?

1. By overcorrecting the missile so that a constant-bearing lead course is maintained
2. By correcting the missile heading so that it changes at the same rate as the target bearing
3. By varying the velocity of the missile so that it is always proportional to that of the target
4. By maintaining a flight path that follows the direct line of sight to the target

46. Which of the following components found in a missile with an active homing guidance system can also be found in a missile with a semiactive homing system?

1. Transmitter only
2. Reference generator only
3. Duplexer only
4. All of the above components

Items 47 and 48 are based on the following list of examples of heat transfer by natural processes:

A. Heated air rising from the earth's surface
B. Heated water rising to the surface of the sea
C. The sun warming the surface of the earth
D. Molten material at the center of the earth warming the surface

47. Which of the examples of heat transfer represents a convection process?

1. A only
2. A and B
3. C
4. D

48. Which of the examples of heat transfer represents a radiation process?

1. A
2. B
3. C
4. D

49. The wavelength of maximum radiation from a hot object depends only on its

1. heat conductivity
2. surface area
3. chemical composition
4. temperature

50. When people deal with radar, they speak of frequencies in megacycles. Why do they usually refer to wavelength in microns when they deal with infrared radiation?

1. Infrared radiation travels at a smaller velocity than radar waves.
2. The numbers involved are of a more convenient size.
3. The instruments used for measuring have an entirely different design.
4. Infrared radiation cannot be reflected like radar waves.

51. If heat is applied to a thermistor that is connected across a battery, how will the current in the circuit change as the temperature increases?

1. The current will increase steadily.
2. The current will decrease steadily.
3. The current will increase abruptly to its maximum value.
4. The current will decrease abruptly to zero.

52. In what way are bolometers, thermistors, and photoconductive cells similar?

1. They are all sensitive to both infrared and visible light radiation.
2. They all have negative temperature coefficients.
3. They are all sensitive to infrared radiation.
4. They are all photoemissive.

53. In a typical passive infrared guidance system, infrared radiations are changed to electrical signals by the action of the

1. spin motor
2. sensing circuits
3. bolometer flakes
4. scan mirror

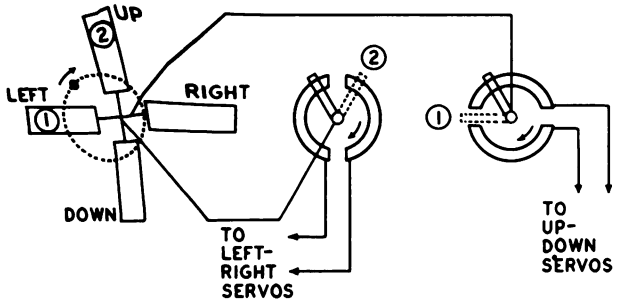


Figure 3J.

54. Which of the bolometer flakes will NOT be heated when the image circle is in the position shown in figure 3J?

1. Up flake only
2. Right flake only
3. Up and down flakes
4. Left and right flakes

55. Which of the bolometer flakes will provide a signal to the missile control circuits when the image circle is in the position shown in figure 3J?

1. Up flake only
2. Right flake only
3. Up and down flakes
4. Left and right flakes

56. Why do the voltages across the bolometer arms shown in figure 3J have no effect on the flight control circuits when the target is dead ahead?

1. The control circuits are inoperative under these conditions.
2. The outputs from opposite arms cancel.
3. The arms are not heated by the image when the target is dead ahead.
4. The arms are not connected to the control circuits.

● Items 57 through 70 are based on three other systems of guidance control: Command guidance, inertial guidance, and preset guidance.

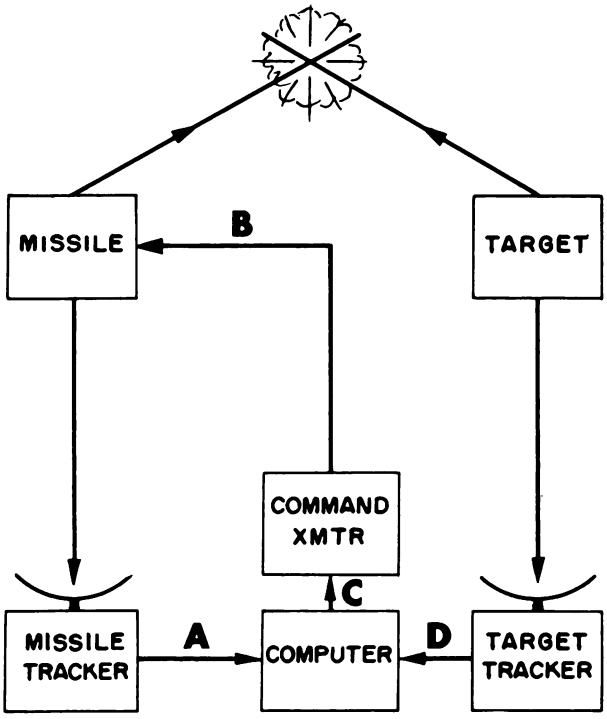


Figure 3K.—Command system.

57. The arrows in the command system shown in figure 3K indicate the flow of information and command signals as well as the motion of the missile and the target. Which of the connecting arrows make up the information link of the system?

1. A only
2. B only
3. B and C
4. A, C, and D

58. The command link of the system shown in figure 3K is composed of which of the connecting arrows?

1. A only
2. B only
3. B and C
4. A, C, and D

Assignment 3

59. The audio-modulated command system represents an improvement over the multiple receiver system in almost every respect. What is the one disadvantage possessed by both systems?

1. Limit of four transmitted functions
2. Poor sensitivity
3. Susceptibility to interference
4. Bulky and complex construction

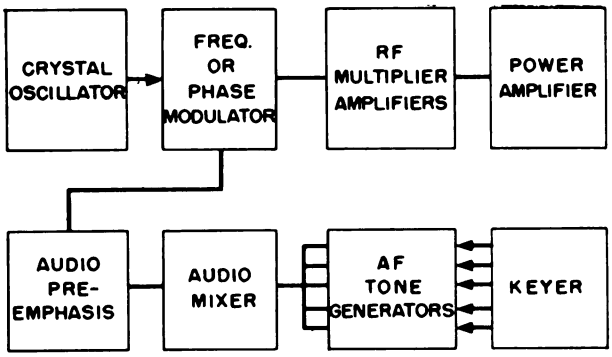


Figure 3L.

60. What is the function of the audio pre-emphasis unit of the command transmitter shown in figure 3L?

1. To provide the power necessary for transmission to the missile
2. To modulate the carrier frequencies with the tone frequencies
3. To combine the separate audio tones into a single signal
4. To effectively decrease high-frequency noise by amplifying only the audio tone frequencies

61. What is the purpose of using a crystal to control the master oscillator of the command transmitter shown in figure 3L?

1. To increase the frequency of the oscillator
2. To increase the amplitude of the output
3. To ensure the stability of the output frequency
4. To decrease high-frequency noise

62. A radar beacon transmitter may be included in a system designed to track small missiles. In such a system, the radar beacon will be used to

1. increase the range at which the missile can be tracked
2. provide information to the tracking radar concerning the missile autopilot operation
3. provide an additional point of reference for the missile-borne portion of the system
4. send command signals to the missile

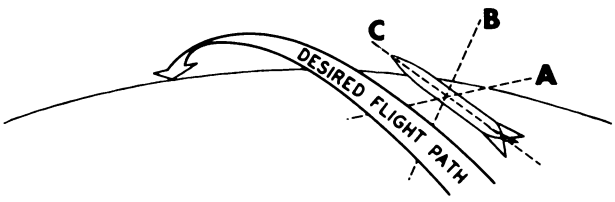


Figure 3M.

The missile shown in figure 3M has an inertial guidance system that includes three mutually perpendicular double-integrating accelerometers. Accelerometer A is mounted with its sensitive axis parallel to the direction labeled A. Accelerometer B is mounted with its sensitive axis parallel to the direction labeled B. Accelerometer C is mounted with its sensitive axis parallel to the direction labeled C.

63. From which of the following signals does the guidance system of the missile shown in figure 3M determine the distance traveled in range?

1. The output of accelerometer A only
2. The output of accelerometer B only
3. The output of accelerometer C
4. The combined outputs of accelerometers A and B

64. Which of the accelerometers mounted in the missile shown in figure 3M could be replaced by a barometric altimeter?

1. Accelerometer A
2. Accelerometer B only
3. Accelerometer C only
4. Both accelerometers B and C

65. How must accelerometers A and C be mounted in the missile shown in figure 3M if they are to function properly?

1. They must be attached securely to the missile frame.
2. They must be attached to a platform that maintains a fixed attitude in space.
3. They must be swivel mounted so they are free to aline themselves with acceleration forces.
4. They must be attached to a platform that maintains a position perpendicular to the earth's pull of gravity.

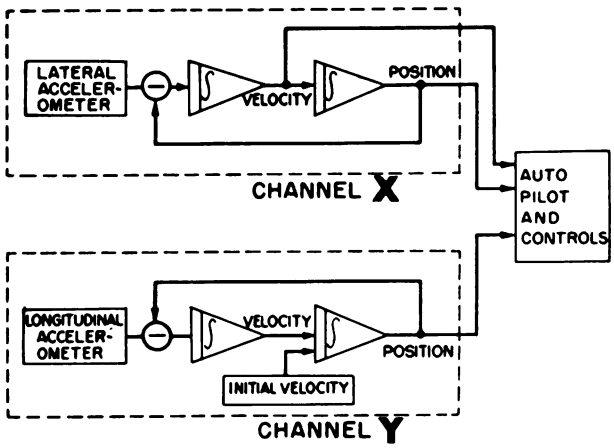


Figure 3N.

66. Which of the units in the system shown in figure 3N will compute the rate at which the missile heading moves away from the desired flight course?

1. The first computer in channel X
2. The second computer in channel X
3. The first computer in channel Y
4. The second computer in channel Y

67. Which of the units shown in figure 3N will perform the computations necessary to tell the missile how far along the flight path it has traveled?

1. The first computer in channel X
2. The second computer in channel X
3. The first computer in channel Y
4. The second computer in channel Y

68. Your textbook describes three simple methods for computing the distance traveled by a missile with preset guidance. Method A includes a propeller and a Veeder-root counter; method B includes an airspeed meter and an integrating device; method C includes an airspeed reference and a clock. How do these three methods compare in accuracy?

1. B is more accurate than A; C is more accurate than A or B.
2. A, B, and C are about the same in accuracy.
3. B and C are about the same in accuracy; A is more accurate than either.
4. A and B are about the same in accuracy; both are more accurate than C.

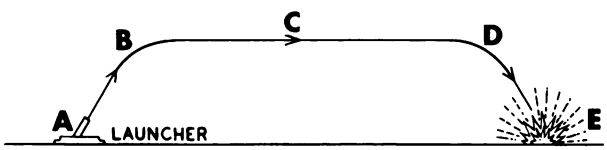


Figure 3O.—Flight path of a surface launched missile.

69. What point in the missile flight path shown in figure 3O is known as the dump point?

1. Point B
2. Point C
3. Point D
4. Point E

70. Practically all missiles make use of preset guidance during one particular portion of their flight. During which portion of the flight path shown in figure 3O will preset guidance probably be used?

1. From A to B
2. From B to C
3. From C to D
4. From D to E

4

MISSILE CONTROL SYSTEMS

Textbook assignment: chapters 11 and 12

● This assignment begins by showing how a simple closed-loop servo system with internal feedback works. It then goes on to show how external feedback can be added and explains how the resulting multiloop servo system works.

The multiloop servo systems used in guided missiles provide both position control and acceleration control. The position-control type servos use rate gyros and the acceleration-control type servos use accelerometers. To help you understand how these servos work, your textbook describes the operation of both these devices.

The multiloop servo system described in the first part of this assignment is a general system; it does not conform to any single system used by the Navy today. However, it will show you what a servo system is designed to do and will prepare you for your study of hydraulic-electric, electric-hydraulic, and electric-pneumatic control systems which will be found in the second part of this assignment.

● Make the following changes in your textbook:

On page 285 change $\frac{V_1}{V_2} = \frac{T_1}{T_2}$ to read $\frac{V_1}{V_2} = \frac{P_2}{P_1}$

On page 287 change $\frac{P_1}{T_2} = \frac{T_1}{T_2}$ to read $\frac{P_1}{P_2} = \frac{T_1}{T_2}$

1. Assume that a continuous type servo system is used in a particular missile to maintain the proper missile heading. The system corrects any errors greater than 2°, but tolerates smaller errors. What is the proper term for this level of 2°?

   1. Switching level
   2. Threshold
   3. Torque level
   4. Trigger

2. The steering controls of an automobile should be considered a servomechanism of the

   1. open-loop discontinuous type
   2. closed-loop discontinuous type
   3. open-loop continuous type
   4. closed-loop continuous type

3. The key difference between a closed-loop automatic control system and an open-loop automatic control system is that the closed-loop system has

   1. an amplifier
   2. a load
   3. a power device
   4. an error detector

4. Assume that a closed-loop angular control circuit is put into operation with the initial conditions $\theta_i = 10°$ and $\theta_o = 0°$. What are the successive values of the error signal as the load is moved into the desired position?

   1. 10°, 9.9°, 9.8°, . . .
   2. 10°, 10.1°, 10.2°, . . .
   3. 0°, 0.1°, 0.2°, . . .
   4. -10°, -10.1°, -10.2°, . . .

5. Assume that the input to a closed-loop system is an electrical voltage. What value does V_o have when the load is correctly positioned if $V_i = -5$ v.?

   1. 0 v.
   2. 5 v.
   3. -5 v.
   4. 10 v.

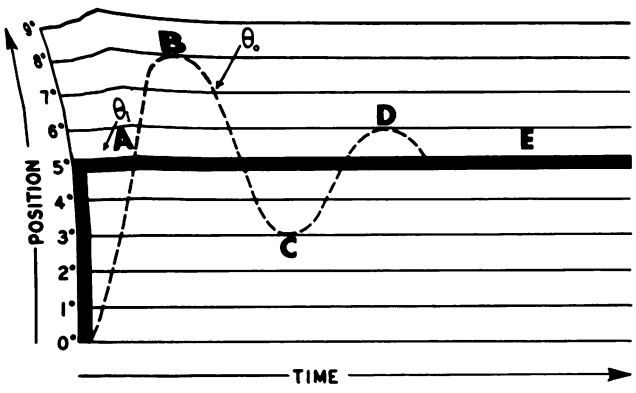


Figure 4A.—Response of a wing-position servo system to a step command from the missile autopilot.

6. At what point in time will the transient error in figure 4A equal 3°?

   1. Point A
   2. Point B
   3. Point C
   4. Point D

7. At what point in time will the transient error in figure 4A be 0°?

   1. Point B
   2. Point C
   3. Point D
   4. Point E

8. What is the value of the steady state error in figure 4A?

   1. 0°
   2. 1°
   3. 3°
   4. 5°

9. What component of a closed-loop servo system develops the turning power needed to drive the output?

   1. Error detector
   2. Controller
   3. Feedback circuits
   4. Autopilot

● Information for items 10 through 13: Assume that you have been assigned to work on a certain missile and that you are studying its roll control system in order to fully understand how it works. A block diagram of the roll control system in this missile is shown in figure 4B.

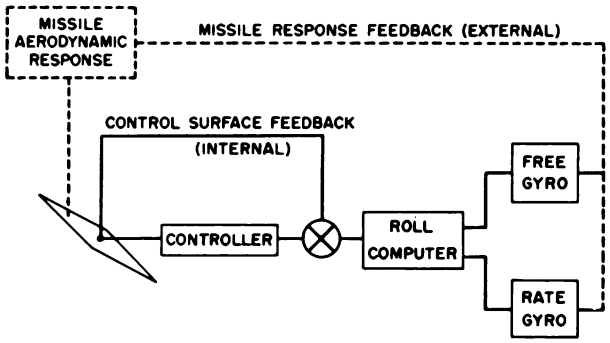


Figure 4B.—Roll control network.

10. What component of your missile's roll control network produces a signal that indicates the roll position of the missile?

    1. Controller
    2. Roll computer
    3. Free gyro
    4. Rate gyro

● Items 11 and 12 refer to the following list of missile roll rates:

   A. 10° in 2 seconds
   B. 20° in 10 seconds
   C. 30° in 5 seconds
   D. 40° in 8 seconds

11. The rate gyro in a roll control system slows down the roll correction when the roll rate is too large. In your missile, the rate gyro acts when the roll rate is greater than 2.5° per second. Because of this, the rate gyro will produce an output at each of the following roll rates except

    1. roll rate A
    2. roll rate B
    3. roll rate C
    4. roll rate D

12. Suppose your missile rolls during the course of its flight. At which of the following roll rates will its rate gyro precess the farthest?

    1. Roll rate A
    2. Roll rate B
    3. Roll rate C
    4. Roll rate D

13. What kind of damping will permit your missile's roll control network to make the proper corrections most rapidly?

    1. Heavy overdamping
    2. Slight overdamping
    3. Critical damping
    4. Slight underdamping

● Multiple feedback loops may be used to modify control system command signals before they are applied to the missile control surfaces so that flight corrections are made with maximum speed and accuracy. The theoretical path control system presented in pages 257 through 260 of your textbook illustrates this point in a general way without going into the details that would be necessary to explain an actual operating system.

● Chapter 11 ends with a short discussion of accelerometers. These are simple devices, and it is easy to understand what they do and how they work. Newton's second law of motion states that the acceleration of an accelerated body is directly proportional to the force acting on that body and that its exact value depends upon the mass. Mathematically the law is written F = ma. The accelerometer solves this equation for the acceleration since the mass of the weight is known and the stretching of the spring is directly proportional to the force.

14. What is the function of the viscous fluid frequently found in an accelerometer?

    1. To transmit the accelerating force from the case to the weight
    2. To provide cooling for the device
    3. To prevent oscillation of the weight
    4. To lubricate the internal parts

15. How many degrees of freedom are possessed by an accelerometer?

    1. 1
    2. 2
    3. 3
    4. 4

● To answer items 16 through 20, you must decide what components to add to the simple hydraulic system shown in figure 4C in order to improve its operation. This system contains only the most basic hydraulic components and will not work very well by itself.

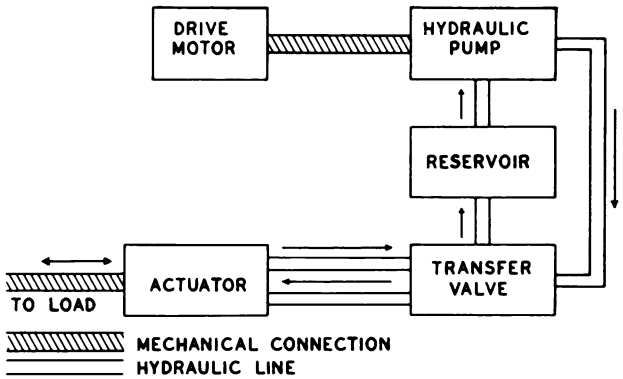


Figure 4C.

16. The action of the positive displacement hydraulic pump causes pressure surges throughout the system. This results in erratic operation of the actuator. Which of the following components should you add to the system in order to dampen the surges and maintain smooth system operation?

    1. Relief valve
    2. Check valve
    3. Accumulator
    4. Feedback line

17. Assume that the transfer valve sticks in a position that completely cuts off the flow of fluid through the valve. The pressure in the feed line builds up until the feed line ruptures. Which of the following components should have been added to the system to prevent a pressure buildup from causing such damage?

    1. Relief valve
    2. Check valve
    3. Accumulator
    4. Flow control valve

18. What kind of filtering element is used in the filter head of a micronic filter?

    1. A series of baffle plates in a small cylinder
    2. Two metal springs compressed into a small cylinder
    3. A piece of treated cellulose specially designed to have a large surface area
    4. A piece of very porous ceramic material

19. During normal operation, tiny metal particles will be worn from the moving parts of the pump, and will become suspended in the hydraulic fluid. Over a period of time, these particles will cause increased wear on the system and may even clog small orifices. What component should be placed in the system to remove these particles and other foreign matter most efficiently?

    1. A magnet in the reservoir
    2. A wire screen filter
    3. A Cuno filter
    4. A micronic filter

20. The actuator does not always respond at the same rate to signals of the same strength. This is due to variations in the rate at which fluid passes through the system. Which of the following valves should be added to the system in order to ensure a constant response?

    1. Check valve
    2. Flow control valve
    3. Relief valve
    4. Servo valve

21. What is the major disadvantage of a simple servo that consists of a solenoid and a pilot valve?

    1. It does not have a rapid positive action.
    2. It cannot be used in high pressure systems.
    3. It cannot provide continuously variable control.
    4. It does not provide for return of fluid to the reservoir.

● The servo valve shown in figure 12-9 of your textbook is a device you may not be familiar with. Before you try to learn how it is designed to provide both positive and negative feedback, you may find it helpful to read over the following description of its basic operation:

When the flapper valve is centered between the two variable nozzles, the fixed orifices restrict the flow of hydraulic fluid equally in both high pressure branches of the line. Due to this equally restricted flow, equal pressure drops occur on both sides of the spool valve, and this valve remains centered so that no pressure is transmitted to the actuator.

Now suppose that the control system energizes the left hand solenoid winding, pulling the flapper valve to the left. Pressure builds up in the left branch of the high pressure line and drops in the right branch, forcing the spool valve to the right until the hydraulic force is balanced by the tension of the centering spring. If the right hand solenoid winding is energized, the entire process is reversed so that the spool valve moves to the left.

22. Which of the following types of hydraulic seals is designed to fit into a groove?

    1. Chevron seal
    2. Crush washer
    3. O-ring
    4. Cup seal

23. Assume that a certain moving part requires a hydraulic seal in one direction only. Which of the following types of seals would probably be used?

    1. Chevron seal
    2. Crush washer
    3. O-ring
    4. Cup seal

24. Which of the following types of hydraulic seal is made of metal?

    1. Chevron seal
    2. Crush washer
    3. O-ring
    4. Cup seal

25. What is the main disadvantage of the simple orifice restrictor?

    1. It can restrict the flow of fluid in only one direction.
    2. It tends to develop leaks that are troublesome to repair.
    3. It cannot be adjusted to change the flow of fluid.
    4. It tends to clog up if used for very long.

26. Before you can use a pressure measurement with the gas laws, you must convert gauge pressure into absolute pressure. What is the absolute pressure of a gas that has a gauge pressure at sea level of 50.0 psi?

    1. 50.0 psia
    2. 55.7 psia
    3. 64.7 psia
    4. 100.0 psia

27. One of the steps in the absolute zero temperature experiments was to lower the temperature of a gas from 0° C. while keeping the pressure unchanged. In these experiments, a 10° C. drop in temperature reduced the volume of the gas to

    1. 263/273 of its value at 0° C.
    2. 265/273 of its value at 0° C.
    3. 268/273 of its value at 0° C.
    4. 272/273 of its value at 0° C.

Assignment 4

28. What is the importance of the temperature -273° C.?

    1. It is the temperature at which the volume of any gas is zero.
    2. It is the temperature at which all molecular motion stops.
    3. It is the temperature at which absolute pressure and gauge pressure become equal.
    4. It is the lowest temperature at which any substance can remain in the gaseous state.

29. What should be your first step in using any of the gas laws in a practical problem?

    1. Subtract 14.7 from all pressure measurements.
    2. Round off all numbers.
    3. Convert all pressures and temperatures into absolute units.
    4. Substitute numerical values for three of the four letters in the equation.

30. Assume that you have pumped air into an air flask that has a volume of 1.5 cubic feet, and that the flask has had a chance to cool down to its original temperature. How much air at sea level pressure have you forced into the air flask if the final gauge pressure after cooling is 800 psi?

    1. About 68 cu. ft.
    2. About 73 cu. ft.
    3. About 78 cu. ft.
    4. About 83 cu. ft.

31. Assume that 12 cubic feet of a gas at a temperature of 17° C. are simultaneously heated to a temperature of 57° C. and permitted to expand while the pressure is held constant. What will be the volume of the heated gas?

    1. 12.6 cu. ft.
    2. 13.7 cu. ft.
    3. 14.7 cu. ft.
    4. 15.8 cu. ft.

32. Twelve cubic feet of nitrogen at a temperature of 20° C. and 150 psig are compressed and pumped into a 4-cubic-foot container. What is the temperature of the gas when the pressure of the gas is 1,000 psig?

    1. 299° C.
    2. 310° C.
    3. 328° C.
    4. 354° C.

33. An air flask mounted in a missile has a volume of 2 cubic feet. When the flask is filled, its pressure measures 1,200 psig at a temperature of 20° C. The missile is fired from an aircraft at a high altitude where the temperature is -13° C. What is the pressure of the air in the air flask if it has the same temperature as the surrounding air at that altitude?

    1. 1,025.7 psig
    2. 1,063.2 psig
    3. 1,112.8 psig
    4. 1,170.4 psig

34. What is the main disadvantage in using an electrical motor to actuate missile control surfaces?

    1. The additional generating equipment needed drastically increases total missile weight.
    2. Not enough torque is produced to ensure positive action of the control surfaces.
    3. The speed of the motor and thus the response of the system cannot be easily regulated.
    4. Control surface movement always lags the control system signal due to the motor's inertia.

35. What determines the speed at which the motor of a variable speed actuator will operate?

    1. The gear train ratio
    2. The strength of the input signal
    3. The tension on the cable drum
    4. The speed of the followup selsyn

● In the pitch electrical system shown in figure 12-14 of your textbook, multiple field windings on a single amplitude generator are used instead of separate generators for each channel. This has the obvious advantage of savings in space and weight, but it has one disadvantage that must be compensated for—variations in the load on the drive motor due to changes in one channel can cause errors. This is why the controller drive motor must be designed to give an almost constant speed regardless of the load.

● Items 36 through 39 refer to the electrical control system using clutches shown in figure 12-15 of your textbook.

36. The output of the pitch amplifier serves to

    1. energize the operating solenoid
    2. vary the speed of the drive motor
    3. energize the brake solenoid
    4. drive the clutch gear

37. What component functions as the controller for the system?

1. Drive motor
2. Solenoid clutch
3. Pitch amplifier
4. Gear reduction unit

38. The drive motor of the system is geared directly to the

1. clutch disk
2. output differential
3. brake disk
4. clutch gear

39. Which of the following statements best describes the way the brake operates after the brake solenoid is energized?

1. The tension of the brake spring is transmitted through the brake arm to the operating shaft, disengaging the output gear from the differential.
2. The brake arm rotates the operating shaft so that the disk assembly engages the clutch cork.
3. The brake arm presses against the operating shaft and forces the disk assembly to engage the brake cork.
4. The brake tension spring releases the brake arm which disengages the operating shaft.

40. How can the response of an on-off control system be made to approximate the smooth action of a proportional system?

1. By using an integrating network to gate the system on and off.
2. By adding a low frequency signal to the error signal so that corrections are made in steps
3. By mechanically vibrating the control surfaces to decrease their rate of movement
4. By using a low frequency signal to gauge the system on and off so that corrections are made intermittently

● Your textbook describes how a dither signal is often used in missiles that employ on-off control. However, a dither signal may also be used in missiles that employ proportional control. By causing a continuous vibration in the wing actuators, it eliminates static friction and thus overcomes a large part of the system's inertia.

41. Assume that a relay is to be used as a switch in a circuit that carries a large current. The most suitable relay for this purpose is one that has a heavy duty spring. This strong spring is needed to

1. carry the heavy current
2. speed the response of the relay when it is deenergized
3. prevent arcing
4. help the magnet close the heavy contacts

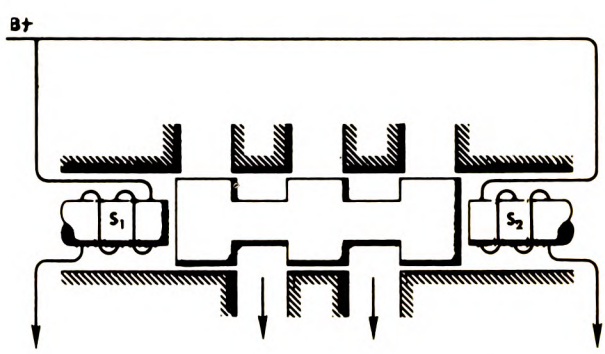


Figure 4D.—Double acting solenoid.

42. Under which of the following conditions will the transfer valve shown in figure 4D be displaced to the right?

1. Current through S-1 is greater than current through S-2.
2. Current through S-2 is greater than current through S-1.
3. Current through S-1 is equal to current through S-2.
4. Both S-1 and S-2 are deenergized.

● Items 43 through 45 refer to the rudder control system shown in figure 12-20 of your textbook.

43. Under which of the following conditions will one of the magnetic amplifiers in the rudder control system produce no output?

1. Current flows through its primary winding while no current flows in its control winding.
2. The signal in its primary winding is out of phase with the signal across its control winding.
3. The signals across its primary and secondary windings are of opposite polarity.
4. The core of its transformer is saturated by current flow through its control winding.

44. The direction of rotation of the induction motor is determined primarily by

    1. the phase of the 26-volt 400-cycle signal with respect to the phase of the 115-volt 400-cycle signal
    2. the amplitude of the 115-volt 3-phase signal
    3. the phase of the input signal with respect to the phase of the 115-volt 400-cycle signal
    4. the average d-c value of the input signal

45. At what point in the rudder control system is the input error signal introduced?

    1. Across the primaries of the magnetic amplifiers
    2. Across the secondaries of the magnetic amplifiers
    3. At the grids of the control tubes
    4. Across the fixed winding of the induction motor

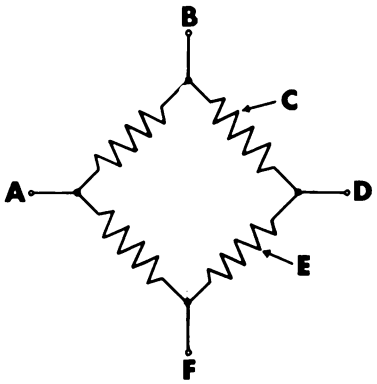


Figure 4E.—Bridge network consisting of four identical resistors

46. With no electromotive force applied to the network in figure 4E, the voltage between any two points in the circuit will of course read zero. If a voltage is applied between points B and F, the voltage will still read zero between points

    1. A and C
    2. B and D
    3. A and D
    4. C and E

47. Suppose that the bridge network in figure 4E is to be used as a pick-off device. If the input voltage is still applied between points B and F, an output voltage should normally be taken between points

    1. A and C
    2. B and D
    3. A and D
    4. C and E

48. What advantage does the Helipot have over an ordinary type of potentiometer?

    1. Higher resistance value
    2. Greater current capacity
    3. Full 360° rotation
    4. Greater precision

● The microsyn and reluctance pick-offs might best be described as variable transformers. Their operation is based on two fundamental principles: (1) Flux density in a magnetic circuit depends on the magnetic permeability of a circuit, and (2) induced voltage in a coil depends on the rate of change of the magnetic flux through the coil. In these pick-offs, a change in displacement alters the permeability of a magnetic circuit, which alters the magnetic flux through the favored coils, which in turn alters the voltage induced in these coils. In this way, the pick-offs convert a change in displacement into a change in output voltage. For a complete discussion of the magnetic principles underlying these pick-offs, refer to chapter 7 of *Basic Electricity* (NavPers 10086).

49. Which of the following pick-off devices will produce a d-c output?

    1. Microsyn
    2. Bridge network
    3. Internally operated reluctance pick-off
    4. Externally operated reluctance pick-off

50. What is the essential difference between the two types of reluctance pick-offs?

    1. The principle of operation
    2. The source of oscillating voltage
    3. The form of the output
    4. The output loading effect

51. What is one important feature of the variable capacity pick-off?

    1. Absence of any moving parts
    2. Small output per unit of displacement
    3. High sensitivity
    4. High current capacity

5

TELEMETERING; HANDLING AND TESTING

Textbook assignment: chapters 13 and 14 .

● The information needed for evaluating guided missile performance can be divided into two kinds—information that can be obtained while the missile is on the ground, and information that can only be obtained while the missile is in flight. The second kind isn't as easy to obtain as the first, but people who do development work on guided missiles have great need for it. Over the years, some fairly complicated equipment has been devised to meet this need.

This equipment is called radio telemetering equipment, and you may have to operate it because, as a GS, you may very well be assigned to a unit working on a missile that is still in the development stage. But even if you end up in some other billet, you should pick up a good knowledge of telemetering techniques and the reasons for their use. It will help give you a well rounded understanding of the fundamental problems of missile design and operation.

1. There are three general methods of obtaining data from missiles and aircraft in flight: (1) By human observers on board, (2) by airborne recorders, and (3) by radio telemetering. The third method is preferred for most missile test flights mainly because

   1. no satisfactory airborne recorders are available
   2. telemetering is less expensive than the other methods
   3. most missiles cannot be recovered after launching
   4. telemetering is less complicated than the other methods

2. Prior to testing in actual flight, the probable flight characteristics of a missile and the compatibility of its components may be determined in the laboratory by means of a computer known as a

   1. missile mockup
   2. systems breadboard
   3. flight simulator
   4. digital analyzer

3. One of the first systems to make use of radio telemetering was designated by the term

   1. "aerosonde"
   2. "theodolite"
   3. "radiosonde"
   4. "transponder"

4. Which of the following kinds of information might be transmitted by means of telemetering?

   1. Temperature of a rocket engine exhaust nozzle only
   2. Phase and amplitude of the output voltage of a missile power supply only
   3. Opening of missile fuel control valves only
   4. All of the above kinds of information

Assignment 5

● Items 5 through 21 are based on the description of F-M/F-M telemetering found in your textbook. Before trying to find the answers to the items in this part of the assignment, you will be wise to study pages 314 through 331 until you are sure that you understand the operation of the entire system. Some of these items refer to table 13-1 on pages 316 and 317 of your textbook. Make sure that you realize that the five optional channels listed in this table can be used **only** IN PLACE OF standard bands 14 through 18. If channel A were used at the same time as channel 14, for example, it would be impossible to tell one from the other because they both have the same center frequency.

● Information for items 5 through 9: Assume that a hypothetical missile designated as the *Robin*, XSAM-N-12 is in the early phase of its development and that you are working on the 18-channel F-M/F-M telemetering system installed in this missile. The telemetering channels correspond to standard bands 1 through 18.

5. What is the maximum number of measurements that can be transmitted by the *Robin*'s telemetering system?

   1. 6
   2. 9
   3. 18
   4. 36

6. Which of the following F-M transmitters is suitable for use in the *Robin*'s telemetering system?

   1. One that operates at 200 mc.
   2. One that operates at 210 mc.
   3. One that operates at 220 mc.
   4. One that operates at 240 mc.

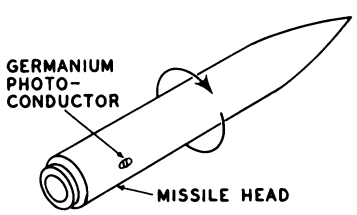


Figure 5A.—Photoconductor mounted on surface of missile head. This produces a small d-c voltage when exposed to the rays of the sun. Spinning of the *Robin* missile causes the light falling on the photoconductor to vary and results in a variation in the amplitude of the photoconductor's output. The frequency of this output variation is equal to the rate of spin of the missile.

7. Assume that the output of the phototube shown in figure 5A is assigned by the test specifications to channel 1 of the telemetering system, where it is used to modulate the subcarrier oscillator. This indicates that the spin of the missile is not expected to exceed the rate of

   1. 60 r. p. m.
   2. 180 r. p. m.
   3. 400 r. p. m.
   4. 1,800 r. p. m.

8. In which two components of the *Robin*'s telemetering system does frequency modulation take place?

   1. Subcarrier oscillator and transmitter
   2. Modulator and bandpass filter
   3. Subcarrier oscillator and discriminator
   4. Transducer and transmitter

9. In the telemetering system of the *Robin*, what is the highest frequency that can be used to modulate a standard band subcarrier oscillator?

   1. 1050 c. p. s.
   2. 2100 c. p. s.
   3. 5250 c. p. s.
   4. 10,500 c. p. s.

10. Assume that you are instructing a group of strikers in the principles of the phase-shift oscillator. What must you do to a single-stage amplifier to make it function like a phase-shift oscillator?

    1. Connect a tank circuit to the plate.
    2. Tie the cathode to the screen grid.
    3. Return a part of the output to the input through a feedback network.
    4. Introduce external signals that will drive the amplifier into unstable operation.

11. What effect will a sharp decrease in the gain of the amplifier tube probably have on the operation of a phase-shift oscillator?

    1. The output frequency will increase.
    2. The output frequency will decrease.
    3. The circuit will cease to oscillate.
    3. The r. m. s. value of the output will increase.

12. A phase-shift oscillator operates at a frequency that is determined by the

    1. gain of the amplifier
    2. shift in phase that occurs in the feedback network
    3. d-c value of the feedback voltage
    4. values of inductance and capacitance in the tank circuit

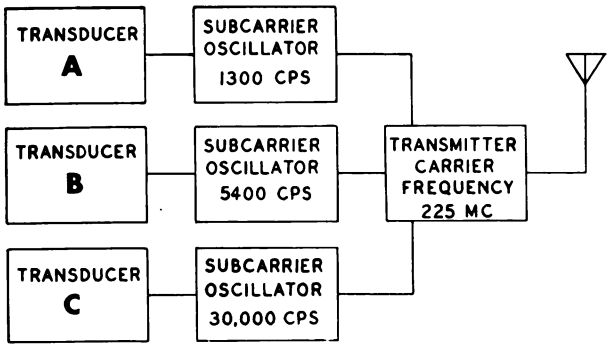


Figure 5B.—Transmitting section of a 3-channel F-M/F-M telemetering system.

13. The sensing element of transducer A in figure 5B is an inductance coil which forms part of the tank circuit of the 1300 c. p. s. subcarrier oscillator. This indicates that the oscillator is probably what type of circuit?

    1. Phase-shift oscillator
    2. Multivibrator
    3. Armstrong oscillator
    4. Hartley oscillator

14. The 5400 and 30,000 c. p. s. subcarriers in figure 5B are phase-shift oscillators which operate like the one shown in figure 13-5 of your textbook. The d-c voltage output of transducers B and C modulate these oscillators by

    1. increasing the gain of the control amplifiers
    2. biasing the grids of the control tubes
    3. providing feedback to the oscillator tank circuits
    4. biasing the grids of the oscillator tubes

15. Assume that in the development of the transmitter signal by the equipment shown in figure 5B, a signal originating in a crystal oscillator passes through two frequency triplers and a frequency doubler. At what point is the telemetering information added to the signal?

    1. Before the oscillator signal goes to the multipliers
    2. After the oscillator signal leaves the multipliers
    3. Before the oscillator signal goes to the triplers but after it leaves the doubler
    4. Before the oscillator signal goes to the second tripler but after it leaves the first tripler

16. Assume that the F-M transmitter shown in figure 5B achieves its output frequency by means of a crystal oscillator, 1 frequency doubler, and 2 frequency triplers. Since the transmitter's output frequency is 225 mc., what is the frequency of its crystal oscillator?

    1. 6.250 mc.
    2. 9.375 mc.
    3. 12.500 mc.
    4. 18.750 mc.

Assignment 5

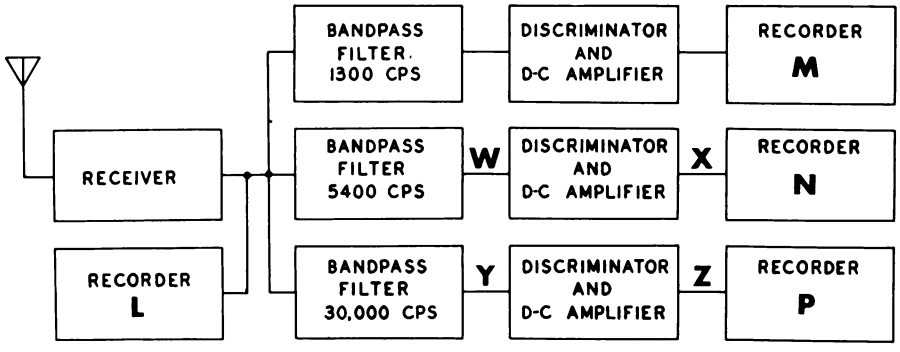


Figure 5C.—Receiving section of a 3-channel F-M/F-M telemetering system.

17. The d-c voltage output of transducer B shown in figure 5B should reappear at what point in the equipment shown in figure 5C?

    1. Point W
    2. Point X
    3. Point Y
    4. Point Z

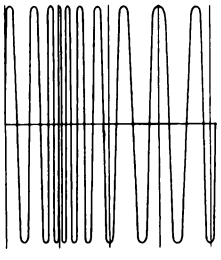


Figure 5D.—Frequency modulation of the 30,000 c. p. s. subcarrier oscillator during one cycle of the sine wave output from transducer C shown in figure 5B.

18. At what point in the receiving station in figure 5C should the signal shown in figure 5D reappear?

    1. Point W
    2. Point X
    3. Point Y
    4. Point Z

19. Which of the following components of the equipment in figure 5C separates an individual subcarrier signal from the complex signal picked up by the antenna?

    1. Limiter
    2. Receiver
    3. Discriminator
    4. Bandpass filter

20. What type of recorder is normally used in applications like recorder L in figure 5C?

    1. Galvanometer oscillograph
    2. Magnetic-tape recorder
    3. Direct writing oscillograph
    4. Oscillograph-record camera

21. The signals fed into recorder P in figure 5C cause a very small mirror to change position, thus deflecting a beam of light which traces these movements on photosensitive paper. This type of recorder is known as

    1. an oscillograph-record camera
    2. a direct writing oscillograph
    3. a fixed-styli recorder
    4. a galvanometer oscillograph

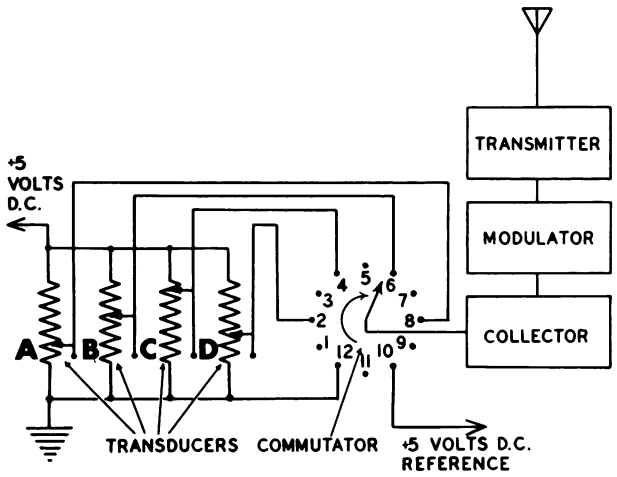


Figure 5E.—Transmitting section of a 4-channel P-W-M/F-M telemetering system.

● The diagram of the system shown in figure 5E has been deliberately simplified for purposes of instruction. In actual operations, open pins 1, 3, 5, etc., are normally grounded to avoid the transmission of any stray signals that may be present on these pins.

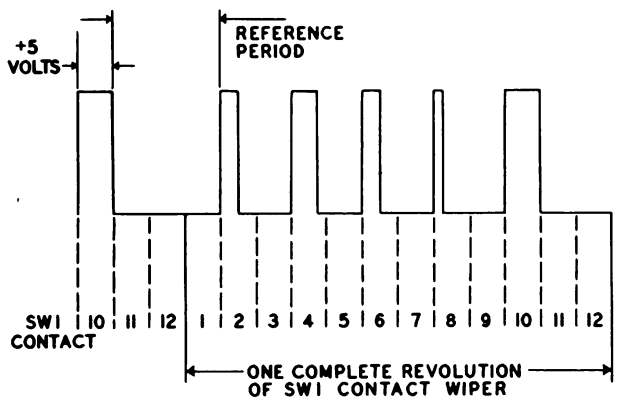


Figure 5F.—Width-modulated pulse chain.

● Items 22 through 28 are based on the description of the P-W-M/F-M telemetering found in pages 331 through 339 of your textbook.

22. What purpose is served by reference pulse number 10 in the equipment shown in figure 5E?

    1. Calibration of the system
    2. Synchronization of receiving station recorders
    3. Measurement of missile power supply voltage
    4. Triggering of receiving station pulse decoders

23. Which of the components shown in figure 5E receives a signal consisting of height-modulated pulses and converts it into a signal like the one shown in figure 5F?

    1. Commutator
    2. Modulator
    3. Transmitter
    4. Collector

24. In the pulse chain shown in figure 5F, the reference period formed by the grounding of the commutator contact is called the

    1. information period
    2. synchronizing interval
    3. calibration pulse
    4. initiating period

25. In the pulse chain shown in figure 5F, pulse number 2 is exactly two-fifths as wide as pulse number 10. This indicates that the output of transducer D is

    1. 2/5 v.
    2. 1 v.
    3. 2 v.
    4. 4 v.

26. The main difference between equipment that can be used to receive the signals sent out by the transmitting equipment shown in figure 5E and equipment that can be used to receive signals sent out by a rate-modulated pulse-telemetering transmitter lies in the

    1. antenna
    2. receiver
    3. decoder
    4. recorder

27. What kind of recorder is generally used in the equipment that receives the signals sent out by the transmitting section shown in figure 5E?

    1. A magnetic-tape recorder
    2. A set of galvanometer oscillographs
    3. An oscilloscope fitted with a movie camera
    4. An oscilloscope fitted with a still camera

Assignment 5

28. Assume that a telemetering channel is fed to a single contact of a mechanical commutator. The rate at which this channel will be sampled is determined by the

    1. number of contacts per section
    2. speed of the rotor
    3. number of rotors
    4. frequency of the transducer output

● Items 29 through 31 refer to the airborne telemetering unit in figure 5G. You will find an explanation of this system on page 338 of your textbook.

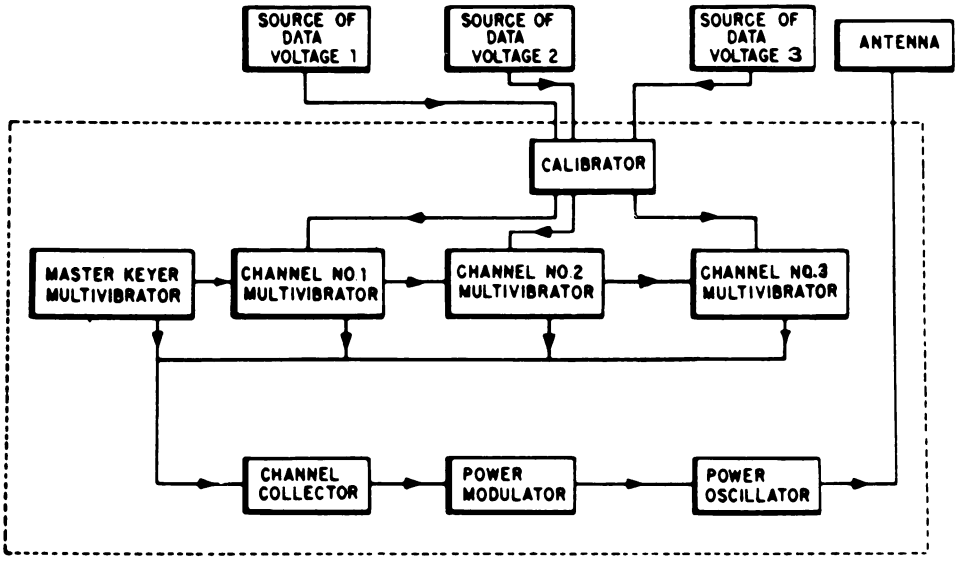


Figure 5G.—Block diagram of 3-channel airborne telemetering unit with electronic commutation.

29. What type of output does the master keyer produce?

    1. A sine wave
    2. A slowly varying direct current
    3. A single pulse when triggered by a pulse
    4. A series of pulses at evenly spaced intervals

30. Assume that you are on duty in a telemetering ground station which receives the signal transmitted by the unit shown in figure 5G. What part of the received signal should you examine in order to determine the original value of data voltage 2?

    1. The height of the second pulse after the initial pulse
    2. The time delay between the initial pulse and the second succeeding pulse
    3. The width of the second pulse after the initial pulse
    4. The time delay between the first and second pulses after the initial pulse

31. The channel No. 3 multivibrator in figure 5G is triggered by the

    1. calibrator
    2. master keyer
    3. channel collector
    4. channel No. 2 multivibrator

32. Missile components are protected from physical damage by the sturdy construction of the shipping container. Additional protection is obtained through the use of

    1. corrugated cardboard inserts
    2. rubberized hair or sponge rubber cushions
    3. fiber padding
    4. bands of hard rubber around the container

33. To determine the moisture content of the air inside a sealed shipping container, you should check the

1. desiccant
2. sealing gaskets
3. humidity indicator
4. O-rings

34. A large, cylindrical, missile-component shipping container is most likely to have a top surface that is

1. channeled
2. flat
3. concave
4. convex

35. In his inspection of a newly arrived shipping container a GS notes a large dent in its side. What procedure should he follow?

1. He should dispose of the container.
2. He should tag the container and have it sent to the repair shop.
3. He should pound the dent out with a rawhide hammer.
4. He should have the container shipped back to the manufacturer.

36. Assume that you are checking out a beam-rider missile with the GO-NO-GO test set designed for it. The missile contains a gyroscope that is normally uncaged about 5 seconds after launching. During the simulated flight produced by the test set, the gyro will be uncaged by a signal from the

1. clock timer
2. manually operated switch
3. programmed tape
4. FM pulse wheel

37. The frequency of the signal produced by the FM pulse wheel in the signal generator chassis is determined by the

1. size of the wheel
2. speed of rotation of the wheel
3. resonant frequency of the pickup coil
4. spacing of the grooves on the wheel

38. On some missiles, one of the most critical measurements made with the GO-NO-GO test set is that of the 6-volt filament voltage. The test set compares the voltage produced with the missile power supply with a 6-volt reference voltage. What indication does the test set give when the missile voltage is too high or too low?

1. The automatic test sequence will be stopped on this measurement.
2. A green light will come on at the end of the test.
3. The test set will automatically disconnect the missile power supply.
4. A red light will be illuminated on the monitor panel.

39. The AM wheel in the signal generator chassis amplitude-modulates the signal generator output by

1. varying the amplitude of the pulses fed to the klystron
2. feeding a modulating signal to the control grid of the klystron
3. varying the negative voltage on the klystron repeller plate
4. varying the attenuation of the klystron output

● Items 40 through 70 are based on general purpose test equipment such as ammeters, voltmeters, ohmmeters, frequency meters, crystal rectifier test sets and r-f power bridges. To get a basic idea of how these devices work, you should consult *Basic Electricity* (NavPers 10086) and *Basic Electronics* (NavPers 10087). For example, you will use the AN/USM-26 frequency meter with its plug-in components for testing missile radar equipment. But before you study it, you should learn about secondary frequency standards as they are described in *Basic Electronics.*

40. Which of the following instruments do GS's use most often to isolate faulty components after they have carefully checked the whole system and know which stage contains the trouble?

1. Ammeter
2. Electrodynamometer-type a-c voltmeter
3. Iron-vane a-c voltmeter
4. D-c voltmeter

Assignment 5

41. Assume that a GS striker is checking a certain component with a voltmeter that has a sensitivity rating lower than the rating specified in the equipment handbook. Even if the component is in perfect condition, the values he gets will probably be different from the standard values because

    1. too great a resistance will be added to the circuit
    2. too much current will drain through the meter
    3. too much current will be dissipated through the shunt
    4. too great a change in the capacitance of the component will result

42. Which of the following instruments is a GS most likely to use on an electric cable to detect leakage in insulation?

    1. Megger
    2. Ohmmeter
    3. Voltmeter
    4. Ammeter

43. The basic function of a cathode-ray oscilloscope is to show visually the changes in a signal of varying current or voltage. One of the things it is used for is to

    1. find the source of distortion in a missile component
    2. check the output of a magnetron for unwanted frequency modulation
    3. measure the bandwidth of a resonant cavity
    4. check a cable for high-resistance shorts

44. Which of the following built-in features of the AN/USM-24 oscilloscope makes this equipment especially suited to guided missile work?

    1. Ability to display square-wave signals without much distortion only
    2. Ability to measure pulse duration only
    3. Ability to measure pulse spacing only
    4. All of the above features

45. You must always use a special test probe with the AN/USM-24 oscilloscope to observe a voltage greater than

    1. .09 v.
    2. 2 v.
    3. 120 v.
    4. 150 v.

46. The operator of an AN/USM-24 oscilloscope measures the time duration of a signal appearing on the screen by means of

    1. fixed interval markers along the traces
    2. a stopwatch calibrated in microseconds
    3. a scale showing the length of the trace
    4. a panel meter calibrated in microseconds

47. Which of the following units of the AN/USM-26 contains gating circuits?

    1. The FR-38A/U frequency meter
    2. The MX-1636/U time interval unit only
    3. The MX-1637/U frequency converter unit only
    4. The MX-1636/U time interval unit and the MX-1637/U frequency converter unit

48. Which of the following components of the AN/USM-26 does a GS use to measure the frequency of a source signal that has a frequency of between 50 and 100 mc.?

    1. The FR-38A/U frequency meter only
    2. The FR-38A/U frequency meter and the time interval unit only
    3. The FR-38A/U frequency meter and the frequency converter unit only
    4. The FR-38A/U frequency meter, the time interval unit, and the frequency converter unit

49. Which of the following measurements can be made with the AN/USM-26?

    1. Duration of the signal only
    2. Duration of the interval between two signals only
    3. Number of signals in a set interval of time only
    4. All of the above measurements

50. How does the operator of the typical resonant cavity wavemeter determine the unknown frequency being measured?

    1. With a calibration chart, whether the wavemeter is used as an absorption meter or a transmission meter
    2. By direct reading, whether the wavemeter is used as an absorption meter or as a transmission meter
    3. With a calibration chart when the wavemeter is used as an absorption meter; by direct reading when it is used as a transmission meter
    4. With a calibration chart when the wavemeter is used as a transmission meter; by direct reading when it is used as an absorption meter

51. In addition to the amount of error of the AN/USM-26 that depends on the accuracy of the frequency standard used to calibrate the equipment, there is a small built-in error in the

1. function selector
2. time-base generator
3. signal-gate circuit
4. digital counter

52. Which of the following wavemeters is NOT suitable for measuring VHF signals?

1. A wavemeter consisting of coils and capacitors
2. A wavemeter containing a butterfly circuit
3. A wavemeter containing an adjustable section of transmission line
4. A wavemeter containing a resonant cavity

53. In which of the following instruments does the amount of energy taken from the signal being measured increase as the instrument is tuned closer and closer to the frequency of the source?

1. Absorption wavemeter only
2. Reaction wavemeter only
3. Absorption wavemeter and reaction wavemeter
4. Transmission wavemeter and absorption wavemeter

54. What range of panel-controlled display time is available to the operator of the AN/USM-26?

1. 0.1 sec. to 2 sec.
2. 0.1 sec. to 5 sec.
3. 0.3 sec. to 5 sec.
4. 0.3 sec. to 10 sec.

● Items 55 and 56 refer to spectrum analyzers. The function of a spectrum analyzer is to provide a visual indication of the frequency components of an amplitude-modulated radio wave.

55. Which of the following indications on the screen of a spectrum analyzer means that the frequency modulation is present in the carrier wave being tested?

1. A spectrum that consists of a single lobe
2. A narrow gap to one side of the center of the spectrum
3. A narrow gap in the center of the spectrum
4. A spectrum that is not symmetrical about the carrier frequency

56. A spectrum analyzer can be used to measure the frequency of a carrier wave if it has a built-in

1. long-persistence screen
2. calibrated attenuator
3. bridge circuit
4. wave trap

● Items 57 through 63 refer to crystal rectifiers. These devices must be handled, tested, and installed with great care because they are easily damaged. They can be made unfit for use by passing too large a current through them, by exposing them to a strong r-f field, or even by letting a static charge discharge through them.

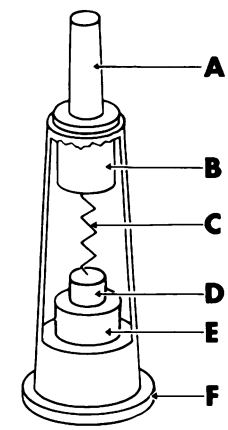


Figure 5H.—Crystal rectifier.

57. The silicon crystal in the crystal rectifier shown in figure 5H is the part labeled

1. B
2. C
3. D
4. E

58. The change from alternating current to rectified current takes place as the current passes between the parts of figure 5H labeled

1. A and B
2. B and C
3. C and D
4. D and E

Assignment 5

59. The complete testing of a crystal rectifier in the field includes separate measurements of

1. front resistance and back resistance only
2. front current and back current only
3. front resistance, back resistance, and back current only
4. front resistance, back resistance, front current, and back current

● Information for items 60 and 61: Assume that you have given front and back resistance checks to four crystal rectifiers and obtained the following results:

Crystal Rectifier	Front Resistance (in ohms)	Back Resistance (in ohms)
A	430	4,700
B	450	4,800
C	500	4,800
D	550	6,600

60. Which of the crystal rectifiers in the preceding information should be rejected on the basis of its front resistance?

1. A
2. B
3. C
4. D

61. Which of the crystal rectifiers in the preceding information is unfit for use because of its back resistance?

1. A
2. B
3. C
4. D

62. You must take surrounding temperatures into account when using a crystal rectifier test set to measure

1. front resistance only
2. back current only
3. front resistance greater than 400 ohms only
4. front resistance and back current

63. Assume that you are in the process of making a back current check with a crystal rectifier test set. You have just finished making the initial voltage adjustment. Your next step is to

1. throw a switch to change the circuit
2. insert the crystal rectifier to be tested
3. remove the crystal rectifier from its "front" holder and place it in its "back" holder
4. adjust the potentiometer until the meter reads zero

64. What happens to the bolometer element when r-f energy falls upon it?

1. Its temperature rises and this makes its resistance change.
2. It converts the r-f energy into measurable direct currents.
3. It amplifies the r-f energy until it is large enough to measure.
4. Its temperature rises and this makes its capacitance change.

65. What is one difference between barretters and thermistors?

1. Thermistors are less subject to variations in surrounding temperature than barretters.
2. Thermistors have negative rather than positive temperature coefficients.
3. Thermistors have much smaller temperature coefficients than barretters.
4. Thermistors have relatively high operating temperatures.

66. What purpose do disk thermistors serve in test set TS-147/UP?

1. To permit the use of smaller batteries
2. To compensate for large skin effects in the bead thermistors
3. To correct for errors caused by variations in surrounding temperature and to compensate for drift
4. To measure the r-f power

67. The initial setting of either a balanced or an unbalanced thermistor bridge can be done with a

    1. frequency meter
    2. calibration chart
    3. standard r-f source
    4. battery fitted with a potentiometer

68. Assume that you are measuring r-f power with a thermistor bridge of the unbalanced type. After setting up the instrument properly, you apply the r-f power. Your next step is to

    1. read the calibrated meter
    2. adjust the potentiometer
    3. adjust the calibrated attenuators
    4. push the button marked "set power"

69. Which of the following purposes is served by the thermistor labeled TH-3 in the unbalanced thermistor bridge described in your textbook?

    1. Making the accuracy of the bridge independent of frequency only
    2. Making frequent resetting of the potentiometer unnecessary only
    3. Keeping the sensitivity of the bridge from changing as the ambient temperature changes only
    4. All of the above purposes

70. In assembling a missile, you use a special clinometer to

    1. measure the angle between a control fin and the horizontal
    2. adjust the travel distance of hydraulic valves
    3. measure linear distances on the missile surface
    4. check the alinement of the missile sections

6

MAINTENANCE AND REPAIR; SAFETY AND FIRST AID

Textbook assignment: chapters 15 and 16

● As a GS 3 or 2, you will perform routine maintenance, troubleshoot faulty equipment, and repair it. This type of work will be one of your chief responsibilities. The purpose of introducing you to the operation of different missile systems was mainly to make you a better repairman. But unless you can effectively isolate faulty equipment and repair it, information about how the missile works will be of little use to you.

The procedures you will use depend largely on the missile you are working on. But there are some skills that apply equally to all missiles—skills such as soldering, reading resistor and capacitor color codes, and identifying parts. You will get a chance to learn about these skills in this assignment.

● In answering items 1 through 47, assume that you are a GS petty officer assigned to a Navy ammunition depot. Your normal duties include all aspects of missile handling and servicing, but these items will mainly describe routine maintenance and repair in the shop.

1. If a GS striker asks you the difference between technical maintenance and depot maintenance, your best answer is that, unlike technical maintenance, depot maintenance includes

   1. maintenance that must be followed by adjustment, alinement, or testing
   2. the rebuilding of subassemblies
   3. the replacement of minor parts
   4. the replacement of subassemblies

2. Assume that a letter from BuOrd refers to a certain ordnance publication by number only. You can get the full title of the publication from the

   1. *Index of Ordnance Publications*, Part I
   2. *Index of Ordnance Publications*, Part II
   3. *Naval Aeronautic Publications Index*, Part I
   4. *Naval Aeronautic Publications Index*, Part II

3. Which of the following missile shop jobs does NOT fall under the heading of troubleshooting?

   1. Locating defective tubes
   2. Isolating faulty capacitors
   3. Periodic lubrication of equipment
   4. Examining equipment for open leads and burnt resistors

● Information for items 4 through 15: Assume that a plug-in subassembly consisting of four video amplifier stages is defective. Your problem is to locate the source of the trouble and then to correct it. Figure 6A shows a component parts layout diagram for this subassembly.

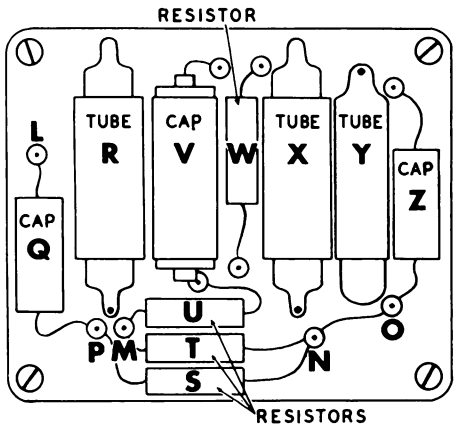


Figure 6A.

4. After you have energized the subassembly and calibrated your oscilloscope, you use the oscilloscope to adjust the level of the signal applied to the input of the

   1. first stage
   2. second stage
   3. third stage
   4. fourth stage

5. Which of the following instruments do you employ to narrow the trouble down to a specific component or connection once you have located the faulty stage?

   1. Oscilloscope
   2. Volt-ohm meter
   3. Megger
   4. Signal generator

6. The malfunction of the subassembly shown in figure 6A is found to be caused by a poorly soldered joint at terminal O. Since the operating temperature of the assembly does not exceed 200° F., the appropriate solder to employ is

   1. 50-50 acid core solder
   2. 60-40 rosin core solder
   3. silver solder with acid flux
   4. silver solder without flux

7. The solder used to make solder connections in electronic equipment contains a core of flux. What is the purpose of this flux?

   1. To increase the flexibility of the soldered joint
   2. To remove oxides from the surfaces to be soldered
   3. To reduce the melting point of the solder
   4. To increase the hardness of the soldered joint

● Items 8 through 15 refer to a GS striker named Jackson who is learning to solder under your direction.

8. You should tell Jackson that before he resolders the faulty connection at point O in figure 6A, he should tin his iron by

   1. coating the tip with rosin flux, then immersing it in a cup of molten tin
   2. filing the pure iron coating on the tip until a fresh, clean surface is exposed
   3. cleaning the tip, then coating it with acid core solder
   4. cleaning the tip, then coating it with rosin core solder

9. You tell Jackson that his soldered joint is likely to be a good one if it is covered with

   1. thick layers of dull-looking solder
   2. a thin layer of shiny solder
   3. thick layers of shiny solder
   4. a thin layer of dull-looking solder

10. If Jackson solders the lead from capacitor Z to connector cup O properly, the insulation sleeving will be

    1. well into the terminal
    2. over 1/2 inch from the terminal
    3. about 1/32 inch from the terminal
    4. completely removed from the lead

11. The recommended way to make the solder connections on a miniature assembly like the one shown in figure 6A involves the use of

    1. a 25-watt soldering iron
    2. an alcohol torch
    3. a 100-watt soldering iron
    4. resistance heating

12. It is very possible that Jackson will damage some part of the miniature assembly in figure 6A if he uses

    1. a heat shunt
    2. jeweler's pliers
    3. normal-size side cutters
    4. rosin core solder

13. In order to protect resistors S and T from heat damage when soldering connector O, Jackson should place a thermal shunt between

    1. connector O and capacitor Z
    2. connectors O and N
    3. connector N and resistors S and T
    4. resistor S and connector P

14. Copper is the best material for Jackson's thermal shunt primarily because of its

    1. malleability
    2. good heat conductivity
    3. low electrical resistance
    4. ductility

Assignment 6

15. Jackson places a clamp shunt between connector O and capacitor Z as close to the capacitor as he can. What is the appearance of the side of the clamp that faces capacitor Z (the side turned away from the connector) when Jackson makes the solder connection?

    1. Dull black and clean
    2. Shiny and clean
    3. Shiny and coated with solder
    4. Dull black and coated with flux

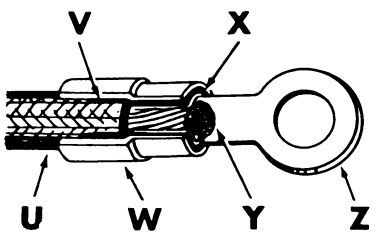


Figure 6B.

● Figure 6B is a cutaway drawing of a preinsulated terminal lug, a type extensively used in missile assemblies instead of soldered connections. In order to aid you in your familiarization with this commonly employed part, items 16 through 19 will emphasize some of the problems encountered in attaching one of these lugs to a cable end.

16. When you describe the terminal lug in figure 6B as either the straight, flag, or right-angles type, you are referring to the design of part

    1. V
    2. W
    3. X
    4. Z

17. Which of the following parts in figure 6B is a feature found only in terminal lugs of the preinsulated type?

    1. V
    2. X
    3. Y
    4. Z

18. When the terminal lug and the cable end shown in figure 6B are properly inserted in tool MS 25037 for crimping, the tool stop is flush against the edge of part

    1. U
    2. V
    3. X
    4. Z

19. Assume that part W of figure 6B is colored blue. In order to have a perfect fit in the terminal lug barrel, part U should be stripped back

    1. 1/2 in.
    2. 3/16 in.
    3. 9/32 in.
    4. 3/8 in.

● When maintaining or repairing a subminiature assembly designed to be carried in a guided missile, you should remember that the assembly must be able to withstand extremes of vibration, acceleration, and temperature. In order to make sure that the assembly will function under these conditions, the GS must perform all repairs with extreme care, making sure that all mountings are solid, all connections secure, and all joints well soldered. The maintenance and repair procedures outlined in the handbook should be followed to the letter, unless superseded by more recent instructions.

20. In the miniature assembly shown in figure 6A, tube X is installed with the red dot up, and it has spaces for 8 leads. If two of the spaces are blank, the lead farthest from the red dot is number

    1. 1
    2. 4
    3. 6
    4. 8

21. In replacing tube X of figure 6A, the location of the proper soldering connection for each lead is obtained from the

    1. parts layout diagram
    2. component wiring diagram
    3. soldering instruction sheet
    4. tube catalog

22. Assume that you are requisitioning tube X as a replacement part for the subassembly. The stock number which must be referred to in the requisition is found in

    1. the parts layout diagram
    2. the component wiring diagram
    3. *Illustrated Parts Breakdown*
    4. the general information section of the missile handbook

23. The component parts list of the missile handbook identifies tube X by a reference number and by a stock number. By which of the following numbers is tube X also likely to be identified in this list?

    1. A manufacturer's part number only
    2. A JAN number only
    3. A manufacturer's part number and an AN number only
    4. An AN number, a JAN number, and a manufacturer's part number

● To answer items **24 through 37**, keep in mind that the JAN designation for fixed composition resistors like the ones shown in figure 6C and the JAN designations for mica and ceramic capacitors like the ones shown in figure 6D both consist of five parts. Each part carries certain information about the component.

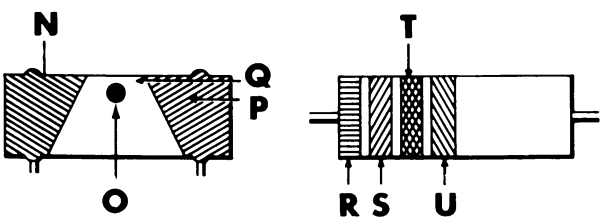


Figure 6C.—Color code for fixed composition resistors. Radial lead resistor on left; axial lead on right.

24. What part of the JAN designation indicates that a particular resistor has a resistance of 16,000 ohms?

    1. The first part
    2. The second part
    3. The fourth part
    4. The fifth part

25. What part of the JAN designation indicates that the maximum ambient temperature for a full load operation of a particular axial lead resistor is 40° C.?

    1. The first part
    2. The second part
    3. The third part
    4. The fifth part

26. The colored band R on the axial-lead resistor in figure 6C corresponds to a portion of the

    1. first part of the JAN designation
    2. second part of the JAN designation
    3. third part of the JAN designation
    4. fourth part of the JAN designation

27. The colors O, P, and Q of the radial-lead resistor in figure 6C correspond to the

    1. fourth part of the JAN designation only
    2. first, second, and third parts of the JAN designation
    3. third, fourth, and fifth parts of the JAN designation
    4. second part of the JAN designation only

28. If the axial-lead resistor shown in figure 6C has a resistance of 16,000 ohms, the band T will be colored

    1. gold
    2. red
    3. yellow
    4. orange

29. Assume that a job requires an axial-lead resistor with a nominal resistance of 25,000 ohms, but that the resistance can have a value as high as 27,500 ohms or as low as 22,500 ohms. Such a resistor will have a band S that is green and a band U that is

    1. black
    2. silver
    3. gold
    4. white

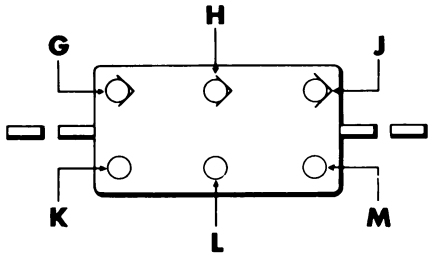
30. Which of the following characteristics is possessed by a radial-lead resistor with a section N that is not colored?

    1. Zero tolerance
    2. High resistance
    3. Low resistance
    4. Wide tolerance

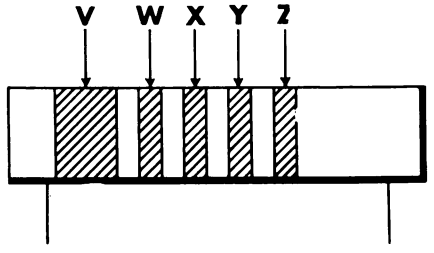
Assignment 6

31. Assume that you need a radial-lead resistor with a resistance of 4,200,000 ohms ±5 percent. What is the color coding of the resistor that meets these requirements?

    1. N silver, O blue, P red, and Q yellow
    2. N gold, O yellow, P yellow, and Q red
    3. N silver, O violet, P yellow, and Q red
    4. N gold, O green, P red, and Q yellow



MICA



CERAMIC

Figure 6D.—Color code for capacito

32. Assume that all of the following designations are possible JAN designations for fixed mica capacitors. Which of them designates a capacitor with a capacitance of 270 μμf?

    1. CM 25 A 273 G
    2. CM 27 E 271 J
    3. CM 27 B 332 G
    4. CM 33 B 272 K

33 Assume that you have four mica capacitors such as the one shown in figure 6D. All of them have a brown dot G, a red dot H, a green dot J, and a brown dot M. They differ only in the color of dot L. If the capacitor you need must have a tolerance of 2 percent, you must use the one with a dot L that is colored

    1. brown
    2. orange
    3. green
    4. red

34. A mica capacitor with a dot G black, H blue, J gray, K orange, L red, and M brown has a temperature coefficient of

    1. 20 μμf.
    2. zero
    3. 0 to -50 parts per million per degree C.
    4. ±100 parts per million per degree C.

35. Which of the following characteristics of a ceramic-dielectric capacitor is indicated by the third part of the JAN designation?

    1. Temperature coefficient tolerance
    2. Capacitance tolerance
    3. Capacitance value
    4. Size and shape

36. The same kind of information that is indicated on a ceramic capacitor by band V in figure 6D is indicated on a mica capacitor case by the dot

    1. G
    2. J
    3. K
    4. M

37. Assume that you requisition a ceramic capacitor with a capacitance of 0.4 μμf, a capacitance tolerance of ±0.25 μμf, and a temperature coefficient of zero. If the capacitor looks like the one in figure 6D, what color will each band be?

    1. Band V black, W black, X yellow, Y black, Z gray
    2. Band V black, W black, X yellow, Y white, Z gray
    3. Band V black, W yellow, X black, Y brown, Z gray
    4. Band V black, W black, X yellow, Y white, Z white

● Information for items 38 through 42: Assume that Burns, GSC, has drawn up a set of instructions for the maintenance of electrical equipment. He has asked you to fill in the lettered spaces so that you can refresh your memory before you begin to use the list yourself to instruct some GS strikers.

1. Brushes: If parts bind, eliminate binding with (T). If this doesn't work, use No. 0000 sandpaper.

2. Commutator: Clean with (U). Remove pitting with (V).

3. Sliprings: Clean and polish with (W). Remove excess polishing agent with (X).

4. Relay contacts: Clean with (Y). If bent, straighten with (Z).

38. Which of the following tools is represented by the letter V in the list?

1. Commutator stick
2. Coarse sandpaper
3. Emery cloth
4. Burnisher

39. Cleaning solvent is represented in the list bv the letter

1. U
2. V
3. W
4. Y

40. Compressed air is represented in the list by the letter

1. T
2. U
3. X
4. Y

41. The tool which is represented by the letter Y in the list should be cleaned with

1. water
2. dry, compressed air
3. pumice
4. alcohol

42. One of your GS strikers begins to use a pair of long-nose pliers for the tool represented by Z in the list. In order to avoid serious damage to the relay, he can make a new tool out of

1. rod stock
2. an old file
3. a wooden stick
4. side cutters

43. Electrical contacts are not the only parts of rotating power equipment that require maintenance. The anti-friction bearings must also be kept in good condition. How should a GS treat the bearings of such equipment between the time he removes and cleans them and the time he replaces them?

1. He should keep them sitting on a clean steel plate.
2. He should keep them wrapped in oil paper.
3. He should keep them sitting on a piece of oiled wood.
4. He should keep them wrapped in a clean cloth.

● In items 44 through 47, assume that you are a GS2 engaged in the maintenance of a group of hydraulic and pneumatic units. Roberts, a GS striker, has been assigned to work with you so that he can benefit from your experience and knowledge.

44. You should tell Roberts that he must be especially careful to keep his tools clean when working on missile hydraulic systems because the

1. hydraulic fluid can react with metal particles to form a corrosive mixture
2. tools he will use are machined to close tolerances and are easily damaged by dirt
3. missile hydraulic system can be damaged by even a small particle of foreign matter
4. presence of dirt in or near the missile system increases the chance of missile failure from a short circuit

45. Assume that you run a missile hydraulic system for its regular 25-hour operation and are now inspecting the filters. What action should you take if you find the micronic input filter dirty?

1. Immerse the element in gasoline.
2. Clean the element with compressed air.
3. Replace the element.
4. Spray the element with water.

46. In which of the following situations is it necessary to flush the missile hydraulic system?

1. Roberts has removed the element of the output filter for inspection.
2. The system has been completely overhauled, including pump replacement.
3. You suspect a leak in the high pressure line from the pump.
4. Roberts discovers a loose fitting near the accumulator.

47. In working with missile pneumatic units, Roberts should use soap and water to

1. loosen tight joints
2. flush the system
3. clean the air filters
4. detect leaks

● The GS is a highly skilled technician who must use his head as much as his hands in solving a particular maintenance problem. As a result, he may become so completely absorbed in the electronic and mechanical aspects of a job that he neglects some of the simpler and more obvious rules of safety. Chapter 16 reemphasizes those simple and obvious rules and adds some rules which may not be so obvious; but its main object is to remind the GS to think in terms of safety.

To work the remaining items in this assignment, assume that you are a GS petty officer assigned to a guided missile cruiser. Throughout the daily routine, you will meet many situations that require a thorough knowledge of safety procedures. When you are supervising lower rated men, you will have to correct them whenever they use unsafe procedures. You must also choose the safe way when you are working by yourself. The following items are of two kinds—those that give you practice in recognizing unsafe procedures when you see them, and those that teach you safety precautions directly.

48. A new group of missiles has arrived from the depot. While Brophy, SN, is uncrating one of them, you should caution him to be especially careful of

1. poisonous hydraulic fluid
2. carbon monoxide
3. the sharp wingtips and tail fins
4. electrical fire

49. Which of the following GS strikers is doing something wrong while inspecting a missile hydraulic system?

1. Brophy, who is clearing the workbench of metal filings
2. Rechs, who is wearing goggles while charging the accumulator
3. Sullivan, who is cleaning the pump with solvent
4. Bettin, who is keeping other personnel clear of the test area

50. Which of the following GS strikers is doing something wrong while uncrating the missiles which have arrived from the depot?

1. Brophy, who is forcing the shell loose with a crowbar
2. Rechs, who is looking up the proper procedures in the missile handbook
3. Sullivan, who is clearing the area of loose cables and unnecessary equipment
4. Bettin, who is placing guards on the wingtips

51. Which of the following GS strikers is doing something wrong while handling gas bottles?

1. Brophy, who is closing all valves on empty cylinders
2. Rechs, who is checking empty cylinders for residual pressure
3. Sullivan, who is using soapy water to check a valve for leaks
4. Bettin, who is adjusting the safety valve on a charged container

52. Rechs, SN, is charging the pressure accumulator of a hydraulic system. Which of the following gases should he use?

1. Oxygen
2. Carbon dioxide
3. Helium
4. Nitrogen

53. A GM striker is carrying a box of missile detonators which are not packed in metal containers. What is the minimum distance that he must maintain from any electronic transmitter?

1. 5 ft.
2. 10 ft.
3. 15 ft.
4. 20 ft.

54. Wertz, GM3, is responsible for the fuzing of a group of missile warheads. Which of the following locations is the best place to perform his work?

1. Forward magazine
2. Ammunition locker
3. Welding shop
4. Specially designated fuze-handling room

55. Which of the following men is doing something wrong while handling rocket motors?

1. Brophy, who rejects a motor that has been dropped on the deck
2. Rechs, who is repairing the motor case with a power drill
3. Sullivan, who grounds the motor case against static electricity
4. Wertz, who keeps clear of a rocket motor for only 20 minutes after a misfire, before he goes to work on it

56. When one of your men is hauling a group of rocket motors on a cart, he should use a dragging chain to

1. pull the cart
2. serve as a ground connection
3. secure the motors to the cart
4. warn others of approaching ordnance material

57. Assume that you are in charge of a crew that is making a wiring check on a missile launcher that is located about 30 feet from your ship's helicopter. When must you keep your crew from smoking?

1. Only as long as there is a missile in the launcher
2. Only if the rotor of the helicopter is turning
3. Only if the helicopter is being refueled
4. As long as they are working on that launcher and the helicopter remains where it is

58. Bettin, SN, is installing a crystal diode in a receiver. In order to prevent damage to the crystal during proper installation, he should ground

1. the crystal holder
2. the motor generator
3. his hand
4. his screwdriver

59. Which of the following GS strikers is following the best procedure in working with electronic equipment?

1. Brophy, who always works alone and never talks to anyone
2. Rechs, who wears a celluloid face shield to protect his eyes
3. Sullivan, who always removes his identification bracelet before starting a job
4. Bettin, who always energizes the equipment before examining it

60. Caution should be exercised when unpacking cathode-ray tubes because of the possibility of

1. explosion
2. implosion
3. radioactive burns
4. gas poisoning

61. Assume that Sullivan, SN, is preparing a solution of sulfuric acid electrolyte. Which of the following methods of mixing the ingredients is the safest?

1. Holding the water at arm's length and pouring it rapidly into the container of acid
2. Filling the battery cells half-full of acid and adding distilled water
3. Pouring the acid slowly into the container of water
4. Pouring the acid and the water simultaneously into the same container

62. While filling a nickel-cadmium battery, Brophy, SN, spills a strong potassium hydroxide solution on his hand. He should immediately wash the hand with

1. plain water
2. soapy water
3. sulfuric acid electrolyte
4. 10-percent acetic acid solution

63. When cleaning electrical equipment, your crew should NEVER use carbon tetrachloride because it can cause

1. a fire
2. damage to insulation
3. an explosion
4. toxic effects on personnel

Assignment 6

64. Rechs, SN, turns the test console power switch to ON, and immediately observes dense smoke issuing forth from the back of the console. The first thing he should do is to

1. call damage control central
2. pour water on the console
3. turn the switch to OFF
4. ask the crew leader what steps to take

65. Which of the following GS strikers is using a tool in an improper manner that should be called to his attention?

1. Brophy, who uses a file to shape the tip of his screwdriver
2. Rechs, who uses pliers to tighten an assembly mounting nut
3. Sullivan, who grounds the case of his power drill
4. Bettin, who uses a key to tighten the chuck on his drill

● Information for items 66 through 69: Assume that Bettin is making an adjustment to a high-voltage power supply when he receives a severe electric shock. He slumps unconscious over his work while still unable to let go of the live equipment.

66. What should be your first step in aiding Bettin?

1. Grab him and pull him free.
2. Call the dispensary.
3. Throw water on him.
4. Cut off the electric current to the power supply.

67. After you have released him from the live equipment, you find that Bettin has stopped breathing. You call the dispensary and then start to apply artificial respiration. When you are in the correct position, your knees will be straddling Bettin's

1. head
2. back
3. waist
4. ankles

68. While you are exerting the force that expells the air from Bettin's lungs, your hand should be placed on his

1. shoulder blades
2. ribs
3. thighs
4. waist

69. Bettin starts breathing again and you treat him for shock. In addition, his hands are badly blistered and charred. What is one of the steps you should take for Bettin's burns if the dispensary is trying to cope with another emergency and medical aid for Bettin will not be available for several hours?

1. Gently rinse the burns with distilled water.
2. Sprinkle the burns with antiseptic powder to prevent infection.
3. Cover the burns with thin pieces of sterile vaseline gauze.
4. Coat the burns with vaseline.

. . . and a final question

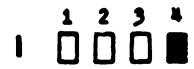
What did you think of this course? One of the major sources of course improvement has been comments and recommendations received from the individual enrollees. The Center appreciates recommendations and constructive criticism of the courses and requests that the commands and the individual enrollees continue to submit this information. Recommendations should be submitted in letter form and must include the full title and NavPers number of the respective course. Further, the Center is available for any counseling or other assistance that the individual commands may require or desire.

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is correct, blacken the APPROPRIATE BOX on this sheet with a soft lead pencil and make a heavy black mark. If you change your mind, erase your first mark completely.

SAMPLE

1. Chicago is:

1. a country
2. a mountain
3. an island
4. a city



FILL OUT BOTH SIDES COMPLETELY

360-A

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GUIDED MISSILEMAN 3 & 2

SCORE

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NAVPERS

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4	☐	☐	☐	☐	34	☐	☐	☐	☐	64	☐	☐	☐	☐	94	☐	☐	☐	☐
5	☐	☐	☐	☐	35	☐	☐	☐	☐	65	☐	☐	☐	☐	95	☐	☐	☐	☐
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8	☐	☐	☐	☐	38	☐	☐	☐	☐	68	☐	☐	☐	☐	98	☐	☐	☐	☐
9	☐	☐	☐	☐	39	☐	☐	☐	☐	69	☐	☐	☐	☐	99	☐	☐	☐	☐
10	☐	☐	☐	☐	40	☐	☐	☐	☐	70	☐	☐	☐	☐	100	☐	☐	☐	☐
11	☐	☐	☐	☐	41	☐	☐	☐	☐	71	☐	☐	☐	☐	101	☐	☐	☐	☐
12	☐	☐	☐	☐	42	☐	☐	☐	☐	72	☐	☐	☐	☐	102	☐	☐	☐	☐
13	☐	☐	☐	☐	43	☐	☐	☐	☐	73	☐	☐	☐	☐	103	☐	☐	☐	☐
14	☐	☐	☐	☐	44	☐	☐	☐	☐	74	☐	☐	☐	☐	104	☐	☐	☐	☐
15	☐	☐	☐	☐	45	☐	☐	☐	☐	75	☐	☐	☐	☐	105	☐	☐	☐	☐
16	☐	☐	☐	☐	46	☐	☐	☐	☐	76	☐	☐	☐	☐	106	☐	☐	☐	☐
17	☐	☐	☐	☐	47	☐	☐	☐	☐	77	☐	☐	☐	☐	107	☐	☐	☐	☐
18	☐	☐	☐	☐	48	☐	☐	☐	☐	78	☐	☐	☐	☐	108	☐	☐	☐	☐
19	☐	☐	☐	☐	49	☐	☐	☐	☐	79	☐	☐	☐	☐	109	☐	☐	☐	☐
20	☐	☐	☐	☐	50	☐	☐	☐	☐	80	☐	☐	☐	☐	110	☐	☐	☐	☐
21	☐	☐	☐	☐	51	☐	☐	☐	☐	81	☐	☐	☐	☐	111	☐	☐	☐	☐
22	☐	☐	☐	☐	52	☐	☐	☐	☐	82	☐	☐	☐	☐	112	☐	☐	☐	☐
23	☐	☐	☐	☐	53	☐	☐	☐	☐	83	☐	☐	☐	☐	113	☐	☐	☐	☐
24	☐	☐	☐	☐	54	☐	☐	☐	☐	84	☐	☐	☐	☐	114	☐	☐	☐	☐
25	☐	☐	☐	☐	55	☐	☐	☐	☐	85	☐	☐	☐	☐	115	☐	☐	☐	☐
26	☐	☐	☐	☐	56	☐	☐	☐	☐	86	☐	☐	☐	☐	116	☐	☐	☐	☐
27	☐	☐	☐	☐	57	☐	☐	☐	☐	87	☐	☐	☐	☐	117	☐	☐	☐	☐
28	☐	☐	☐	☐	58	☐	☐	☐	☐	88	☐	☐	☐	☐	118	☐	☐	☐	☐
29	☐	☐	☐	☐	59	☐	☐	☐	☐	89	☐	☐	☐	☐	119	☐	☐	☐	☐
30	☐	☐	☐	☐	60	☐	☐	☐	☐	90	☐	☐	☐	☐	120	☐	☐	☐	☐

FILL OUT BOTH SIDES COMPLETELY

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is correct, blacken the APPROPRIATE BOX on this sheet with a soft lead pencil and make a heavy black mark. If you change your mind, erase your first mark completely.

SAMPLE

1. Chicago is:

1. a country
2. a mountain
3. an island
4. a city

	1	2	3	4
1	☐	☐	☐	■

FILL OUT BOTH SIDES COMPLETELY

360-A

ASSIGNMENT NO. ____

PLEASE FILL IN

Fold along dotted line

NAVY DEPARTMENT
U. S. NAVAL CORRESPONDENCE COURSE CENTER
SCOTIA 2, NEW YORK

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
NAVY DEPARTMENT

NAME _____

ADDRESS _____

_____

Print or type your name and address for return mailing

NAME _____ (LAST FIRST MIDDLE)

GUIDED MISSILEMAN 3 & 2

RATING _____ SERVICE No. _____

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE ☐ OTHER BRANCH (SPECIFY) _____

ASSIGNMENT No. _____ DATE MAILED _____

SCORE

DO NOT WRITE IN THIS SPACE.

NAVPERS

91360-A

	1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4
1	☐	☐	☐	☐	31	☐	☐	☐	☐	61	☐	☐	☐	☐	91	☐	☐	☐	☐
2	☐	☐	☐	☐	32	☐	☐	☐	☐	62	☐	☐	☐	☐	92	☐	☐	☐	☐
3	☐	☐	☐	☐	33	☐	☐	☐	☐	63	☐	☐	☐	☐	93	☐	☐	☐	☐
4	☐	☐	☐	☐	34	☐	☐	☐	☐	64	☐	☐	☐	☐	94	☐	☐	☐	☐
5	☐	☐	☐	☐	35	☐	☐	☐	☐	65	☐	☐	☐	☐	95	☐	☐	☐	☐
6	☐	☐	☐	☐	36	☐	☐	☐	☐	66	☐	☐	☐	☐	96	☐	☐	☐	☐
7	☐	☐	☐	☐	37	☐	☐	☐	☐	67	☐	☐	☐	☐	97	☐	☐	☐	☐
8	☐	☐	☐	☐	38	☐	☐	☐	☐	68	☐	☐	☐	☐	98	☐	☐	☐	☐
9	☐	☐	☐	☐	39	☐	☐	☐	☐	69	☐	☐	☐	☐	99	☐	☐	☐	☐
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15	☐	☐	☐	☐	45	☐	☐	☐	☐	75	☐	☐	☐	☐	105	☐	☐	☐	☐
16	☐	☐	☐	☐	46	☐	☐	☐	☐	76	☐	☐	☐	☐	106	☐	☐	☐	☐
17	☐	☐	☐	☐	47	☐	☐	☐	☐	77	☐	☐	☐	☐	107	☐	☐	☐	☐
18	☐	☐	☐	☐	48	☐	☐	☐	☐	78	☐	☐	☐	☐	108	☐	☐	☐	☐
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26	☐	☐	☐	☐	56	☐	☐	☐	☐	86	☐	☐	☐	☐	116	☐	☐	☐	☐
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28	☐	☐	☐	☐	58	☐	☐	☐	☐	88	☐	☐	☐	☐	118	☐	☐	☐	☐
29	☐	☐	☐	☐	59	☐	☐	☐	☐	89	☐	☐	☐	☐	119	☐	☐	☐	☐
30	☐	☐	☐	☐	60	☐	☐	☐	☐	90	☐	☐	☐	☐	120	☐	☐	☐	☐

FILL OUT BOTH SIDES COMPLETELY

2

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is correct, blacken the APPROPRIATE BOX on this sheet with a soft lead pencil and make a heavy black mark. If you change your mind, erase your first mark completely.

SAMPLE

1. Chicago is:

1. a country
2. a mountain
3. an island
4. a city

	1	2	3	4
1	☐	☐	☐	■

FILL OUT BOTH SIDES COMPLETELY

360-A

ASSIGNMENT NO. ____

PLEASE FILL IN

Fold along dotted line

NAVY DEPARTMENT
U. S. NAVAL CORRESPONDENCE COURSE CENTER
SCOTIA 2, NEW YORK

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
NAVY DEPARTMENT

NAME _____

ADDRESS _____

_____

Print or type your name and address for return mailing

NAME _____ (LAST) (FIRST) (MIDDLE)

GUIDED MISSILEMAN 3 & 2

RATING _____ SERVICE No. _____

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE ☐ OTHER BRANCH (SPECIFY) _____

ASSIGNMENT No. _____ DATE MAILED _____

SCORE

DO NOT WRITE IN THIS SPACE.

NAVPERS

91360-A

	1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4
1	☐	☐	☐	☐	31	☐	☐	☐	☐	61	☐	☐	☐	☐	91	☐	☐	☐	☐
2	☐	☐	☐	☐	32	☐	☐	☐	☐	62	☐	☐	☐	☐	92	☐	☐	☐	☐
3	☐	☐	☐	☐	33	☐	☐	☐	☐	63	☐	☐	☐	☐	93	☐	☐	☐	☐
4	☐	☐	☐	☐	34	☐	☐	☐	☐	64	☐	☐	☐	☐	94	☐	☐	☐	☐
5	☐	☐	☐	☐	35	☐	☐	☐	☐	65	☐	☐	☐	☐	95	☐	☐	☐	☐
6	☐	☐	☐	☐	36	☐	☐	☐	☐	66	☐	☐	☐	☐	96	☐	☐	☐	☐
7	☐	☐	☐	☐	37	☐	☐	☐	☐	67	☐	☐	☐	☐	97	☐	☐	☐	☐
8	☐	☐	☐	☐	38	☐	☐	☐	☐	68	☐	☐	☐	☐	98	☐	☐	☐	☐
9	☐	☐	☐	☐	39	☐	☐	☐	☐	69	☐	☐	☐	☐	99	☐	☐	☐	☐
10	☐	☐	☐	☐	40	☐	☐	☐	☐	70	☐	☐	☐	☐	100	☐	☐	☐	☐
11	☐	☐	☐	☐	41	☐	☐	☐	☐	71	☐	☐	☐	☐	101	☐	☐	☐	☐
12	☐	☐	☐	☐	42	☐	☐	☐	☐	72	☐	☐	☐	☐	102	☐	☐	☐	☐
13	☐	☐	☐	☐	43	☐	☐	☐	☐	73	☐	☐	☐	☐	103	☐	☐	☐	☐
14	☐	☐	☐	☐	44	☐	☐	☐	☐	74	☐	☐	☐	☐	104	☐	☐	☐	☐
15	☐	☐	☐	☐	45	☐	☐	☐	☐	75	☐	☐	☐	☐	105	☐	☐	☐	☐
16	☐	☐	☐	☐	46	☐	☐	☐	☐	76	☐	☐	☐	☐	106	☐	☐	☐	☐
17	☐	☐	☐	☐	47	☐	☐	☐	☐	77	☐	☐	☐	☐	107	☐	☐	☐	☐
18	☐	☐	☐	☐	48	☐	☐	☐	☐	78	☐	☐	☐	☐	108	☐	☐	☐	☐
19	☐	☐	☐	☐	49	☐	☐	☐	☐	79	☐	☐	☐	☐	109	☐	☐	☐	☐
20	☐	☐	☐	☐	50	☐	☐	☐	☐	80	☐	☐	☐	☐	110	☐	☐	☐	☐
21	☐	☐	☐	☐	51	☐	☐	☐	☐	81	☐	☐	☐	☐	111	☐	☐	☐	☐
22	☐	☐	☐	☐	52	☐	☐	☐	☐	82	☐	☐	☐	☐	112	☐	☐	☐	☐
23	☐	☐	☐	☐	53	☐	☐	☐	☐	83	☐	☐	☐	☐	113	☐	☐	☐	☐
24	☐	☐	☐	☐	54	☐	☐	☐	☐	84	☐	☐	☐	☐	114	☐	☐	☐	☐
25	☐	☐	☐	☐	55	☐	☐	☐	☐	85	☐	☐	☐	☐	115	☐	☐	☐	☐
26	☐	☐	☐	☐	56	☐	☐	☐	☐	86	☐	☐	☐	☐	116	☐	☐	☐	☐
27	☐	☐	☐	☐	57	☐	☐	☐	☐	87	☐	☐	☐	☐	117	☐	☐	☐	☐
28	☐	☐	☐	☐	58	☐	☐	☐	☐	88	☐	☐	☐	☐	118	☐	☐	☐	☐
29	☐	☐	☐	☐	59	☐	☐	☐	☐	89	☐	☐	☐	☐	119	☐	☐	☐	☐
30	☐	☐	☐	☐	60	☐	☐	☐	☐	90	☐	☐	☐	☐	120	☐	☐	☐	☐

FILL OUT BOTH SIDES COMPLETELY

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is correct, blacken the APPROPRIATE BOX on this sheet with a soft lead pencil and make a heavy black mark. If you change your mind, erase your first mark completely.

SAMPLE

1. Chicago is:
   1. a country
   2. a mountain
   3. an island
   4. a city

	1	2	3	4
1	☐	☐	☐	■

FILL OUT BOTH SIDES COMPLETELY

360-A

ASSIGNMENT NO. ____

PLEASE FILL IN

Fold along dotted line

NAVY DEPARTMENT
U. S. NAVAL CORRESPONDENCE COURSE CENTER
SCOTIA 2, NEW YORK

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
NAVY DEPARTMENT

NAME _____

ADDRESS _____

_____

Print or type your name and address for return mailing

NAME _____ LAST FIRST MIDDLE

GUIDED MISSILEMAN 3 & 2

RATING _____ SERVICE No. _____

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE ☐ OTHER BRANCH (SPECIFY) _____

ASSIGNMENT No. _____ DATE MAILED _____

SCORE

DO NOT WRITE IN THIS SPACE.

NAVPERS

91360-A

	1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4
1	☐	☐	☐	☐	31	☐	☐	☐	☐	61	☐	☐	☐	☐	91	☐	☐	☐	☐
2	☐	☐	☐	☐	32	☐	☐	☐	☐	62	☐	☐	☐	☐	92	☐	☐	☐	☐
3	☐	☐	☐	☐	33	☐	☐	☐	☐	63	☐	☐	☐	☐	93	☐	☐	☐	☐
4	☐	☐	☐	☐	34	☐	☐	☐	☐	64	☐	☐	☐	☐	94	☐	☐	☐	☐
5	☐	☐	☐	☐	35	☐	☐	☐	☐	65	☐	☐	☐	☐	95	☐	☐	☐	☐
6	☐	☐	☐	☐	36	☐	☐	☐	☐	66	☐	☐	☐	☐	96	☐	☐	☐	☐
7	☐	☐	☐	☐	37	☐	☐	☐	☐	67	☐	☐	☐	☐	97	☐	☐	☐	☐
8	☐	☐	☐	☐	38	☐	☐	☐	☐	68	☐	☐	☐	☐	98	☐	☐	☐	☐
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FILL OUT BOTH SIDES COMPLETELY

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SAMPLE

1. Chicago is:

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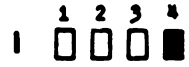
2. a mountain
3. an island
4. a city



FILL OUT BOTH SIDES COMPLETELY

360-A

ASSIGNMENT NO. ____

PLEASE FILL IN

Fold along dotted line

NAVY DEPARTMENT
U. S. NAVAL CORRESPONDENCE COURSE CENTER
SCOTIA 2, NEW YORK

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
NAVY DEPARTMENT

NAME _____

ADDRESS _____

_____

Print or type your name and address for return mailing

NAME _____ (LAST) (FIRST) (MIDDLE)

RATING _____ SERVICE No. _____

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE ☐ OTHER BRANCH (SPECIFY) _____

ASSIGNMENT No. _____ DATE MAILED _____

GUIDED MISSILEMAN 3 & 2

SCORE

DO NOT WRITE IN THIS SPACE.

NAVPERS

91360-A

	1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4
1	☐	☐	☐	☐	31	☐	☐	☐	☐	61	☐	☐	☐	☐	91	☐	☐	☐	☐
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3	☐	☐	☐	☐	33	☐	☐	☐	☐	63	☐	☐	☐	☐	93	☐	☐	☐	☐
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30	☐	☐	☐	☐	60	☐	☐	☐	☐	90	☐	☐	☐	☐	120	☐	☐	☐	☐

FILL OUT BOTH SIDES COMPLETELY

DIRECTIONS: Read each question and its numbered answers. When you have decided which answer is correct, blacken the APPROPRIATE BOX on this sheet with a soft lead pencil and make a heavy black mark. If you change your mind, erase your first mark completely.

SAMPLE

1. Chicago is:

1. a country
2. a mountain
3. an island
4. a city

	1	2	3	4
1	☐	☐	☐	■

FILL OUT BOTH SIDES COMPLETELY

360-A

ASSIGNMENT NO. ____

PLEASE FILL IN

Fold along dotted line

NAVY DEPARTMENT
U. S. NAVAL CORRESPONDENCE COURSE CENTER
SCOTIA 2, NEW YORK

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
NAVY DEPARTMENT

NAME _____

ADDRESS _____

_____

Print or type your name and address for return mailing

NAME _____ (LAST FIRST MIDDLE)

RATING _____ SERVICE No. _____

☐ USN ☐ USNR ☐ ACTIVE ☐ INACTIVE ☐ OTHER BRANCH (SPECIFY) _____

ASSIGNMENT No. _____ DATE MAILED _____

GUIDED MISSILEMAN 3 & 2

SCORE

DO NOT WRITE IN THIS SPACE.

NAVPERS

91360-A

	1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4
1	☐	☐	☐	☐	31	☐	☐	☐	☐	61	☐	☐	☐	☐	91	☐	☐	☐	☐
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FILL OUT BOTH SIDES COMPLETELY

TEXTBOOK(S) MUST BE RETURNED

A Letter of Satisfactory Completion will be issued to you only after all study materials (textbook/s and equipment) loaned with this course have been returned and credited to your record.

In the event of disenrollment, all study materials must also be returned.

To insure that you are credited with the return of these materials, fill out this form and attach it to the inside front cover of the basic text before mailing it to the Center.

PRINT CLEARLY

NAME OF CORRESPONDENCE COURSE	NAVPERS NO.
GUIDED MISSILEMAN 3 AND 2	91360-A

NAME *Last* *First* *Middle*

RANK/RATE	DESIGNATOR	FILE/SERVICE NO.

REASON FOR RETURNING STUDY MATERIALS:

Check one

- ☐ COURSE COMPLETED *(Date)* _____
- ☐ DISENROLLMENT FROM COURSE
- ☐ OTHER REASON *(Specify)* _____

NOTICE: I DESIRE MY COMPLETION LETTER MAILED TO ME AT:
(Give complete mailing address)

_____

_____

_____

MY SERVICE RECORD IS HELD BY: *(Give complete mailing address)*

ACTIVITY _____

ADDRESS _____

SIGNATURE OF ENROLLEE _____

MATERIAL CREDIT FORM-3ND-NCCC-86 (REV.3/57)

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